CORRECTIVE MEASURES STUDY REPORT
PHASE I

Prepared For:

REFINED METALS CORPORATION

Project No. 2003-1046-02
June 22, 2004
Revised May 6, 2005

Refined Metals Corporation

May 6, 2005

Mr. Jonathan Adenuga
Corrective Action Branch
Environmental Protection Agency, Region 5
77 West Jackson Boulevard
Chicago, IL 60604-3590

Re: Revised Phase I Corrective Measures Study Report
Refined Metals Facility
Beech Grove, Indiana
IND 000 718 130

Dear Mr. Adenuga,

Please find enclosed the revised Phase I Corrective Measures Study Report that has been prepared in response to EPA comments.

I certify under penalty of perjury that the information contained in or accompanying the enclosed revised Phase I Corrective Measures Study Report is, to the best of my knowledge after thorough investigation, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,

REFINED METALS CORPORATION

Matt Love

Matthew A. Love

cc: Ms. Ruth Jean – IDEM
Paul G. Stratman, P.E., P.G. – Advanced GeoServices Corporation

CORRECTIVE MEASURES STUDY REPORT
PHASE I

Prepared For:

REFINED METALS CORPORATION

Prepared By:

ADVANCED GEOSERVICES CORP.
West Chester, Pennsylvania

Project No. 2003-1046-02
June 22, 2004
Revised May 6, 2005

TABLE OF CONTENTS

PAGE NO.

ATTACHMENTS

1.0 INTRODUCTION

Presented herein, is the revised Phase I Corrective Measures Study (CMS) Report for the Refined Metals Corporation (RMC) facility in Beech Grove, Indiana. Pursuant to the CMS Work Plan, approved by USEPA in a letter dated November 5, 2003, this report has been prepared to present the results of the additional sampling activities and the preliminary risk assessment results. The original version was submitted on June 22, 2004. This submission has been revised to reflect the comments made by the USEPA in a letter dated January 18, 2005. This revision also includes changes made in response to USEPA comments in a letter dated August 17, 2004 and communications between USEPA and Refined subsequent to the January 18, 2005 letter. A description of the activities is provided in the following sections. Copies of the revised CMS Activities Summary Report and revised Baseline Human Health Risk Assessment are provided as attachments.

2.0 FIELD ACTIVITIES

Based on an evaluation of previous investigation results following the Phase II RCRA Facility Investigation (RFI), a determination was made that additional characterization sampling was required for sediment and groundwater at the RMC Site. The sediment sampling consisted of collecting additional samples from the drainage ditch along the CSX Transportation railroad right-of-way north of the facility and from the grass lined drainage ditch along the west side of Arlington Avenue. Sediment samples were collected from six locations along the railroad drainage ditch and four locations in the Arlington Avenue drainage ditch. Two samples were collected at each location. Along Arlington Avenue, one sample was collected from the 0 to 6-inch depth and the second from the 6 to 12-inch depth. Along the railroad right-of-way, they were collected from 0 to 3 inches and 3 to 10 inches. The depth of the railroad samples was consistent with the requirements for soil samples, although they were intended to be consistent with the 0 to 6-inch and 6 to 12-inch depths for sediment samples. The change in depth was inadvertent and was not detected until review of sampling logs after the completion of sampling. For the metals included in the analysis, the shallower depths likely provide higher concentrations in the 0 to 3-inch and 3 to 10-inch samples when compared to a 0 to 6-inch sample or 6 to 12-inch sample, respectively, from the same location,

Groundwater sampling included the installation of three piezometers in the area north and east of the former manufacturing area. The piezometers were installed with the intent of further refining groundwater flow direction prior to selection of locations for the new monitoring wells. The piezometers were allowed to set for 24 hours before groundwater level measurements were taken from the existing shallow monitoring wells at the north end of the former manufacturing area and the piezometers. Groundwater flow direction was re-assessed based on the measurements and the locations for two new groundwater-monitoring wells were selected. The new groundwater monitoring wells were installed using hollow stem auger (HSA) drilling techniques. The piezometers were abandoned after groundwater level measurements were taken. Groundwater samples were collected from all the Site groundwater monitoring wells between October 26 and 28, 2003 using low flow sample collection techniques.

A complete description of the sediment and groundwater sampling activities is provided in the revised Phase I CMS Activities Summary Report which is provided as Attachment 1 to this report. No changes were made to the Phase I CMS Activities Summary Report since submission of the October 12, 2004 submission.

3.0 ANALYTICAL RESULTS

3.1 GROUNDWATER

Shallow groundwater at the Site is perched and discontinuous and is not used for any purpose. Groundwater samples collected from the shallow groundwater monitoring wells in the north end of the former manufacturing area (MW-2, 7 and 8) gave unfiltered results for total lead in excess of the Indiana Department of Environmental Management (IDEM) Residential Default RISC Criteria (15 ug/L). Analysis of filtered groundwater samples from those wells for lead from the same sampling event were at or below the IDEM Residential Default RISC Criteria. Filtered and unfiltered results for arsenic in MW-1, MW-2, MW-7 and MW-8, and unfiltered results only for MW-3, MW-5 and MW-10 were above the background concentration for arsenic (8.5 µg/l) calculated in the Phase II RFI. No other parameters for MW-2, MW-7 and MW-8 or any of the parameters analyzed for any other well on-site exceeded the IDEM Residential Default RISC Criteria.

3.2 SEDIMENT

Concentrations of lead in the shallow surface sediment samples collected at the depth of 0-3 inches ranged from 617 mg/kg to 14,800 mg/kg and concentrations or arsenic ranged from 12 mg/kg to 169 mg/kg at this depth. Concentrations of lead in the shallow surface sediment samples collected at the depth of 0-6 inches ranged from 411 mg/kg to 874 mg/kg and concentrations of arsenic ranged from 11 mg/kg to 12 mg/kg at this depth. The calculated background for arsenic in shallow surface soil (10.5 mg/kg) was exceeded in all samples. The cleanup level for lead calculated in the Human Health Risk Assessment (Attachment 2)(15,916 m/kg) was not exceeded in these samples.

Concentrations of lead in the subsurface sediment samples collected at the depth of 3-10 inches ranged from 403 mg/kg to 15,700 mg/kg and concentrations of arsenic ranged from 9 mg/kg to 216 mg/kg at this depth. Concentrations of lead in the samples collected at the depth of 6-12 inches ranged from 24 mg/kg to 1,470 mg/kg and concentrations of arsenic ranged from 8.3 mg/kg to 15 mg/kg at this depth. The calculated background concentrations for arsenic in subsurface soil (7.9 mg/kg) was exceeded in all samples. The calculated cleanup level for lead (15,916 mg/kg) was not exceeded in these samples.

4.0 PRELIMINARY RESULTS OF RISK ASSESSMENT

Gradient Corporation (Cambridge, MA) conducted the Baseline Human Health Risk Assessment (Risk Assessment) for RMC. Pursuant to the CMS Work Plan, the Risk Assessment evaluated a variety of exposure scenarios for lead and arsenic for workers at the facility and on the adjacent Citizens Gas property. The evaluation determined that the calculated risk for existing arsenic levels at the Site are within the USEPA target risk ranges for the exposure scenarios evaluated. The lead risk evaluation determined that soil lead concentrations in some areas of the Site create a predicted (95% UCL) blood lead >10ug/dl for the construction worker in the "on-site" area, and for the groundskeeper and plant worker in the "grassy area".

Results of the risk assessment for lead include a Preliminary Remediation Goal (PRG) for each of the exposure scenarios which predict a 95% UCL blood lead >10 ug/dl. The model also provides a Remedial Action Level (RAL), which represents the soil cleanup concentration that will result in remaining soil having an average soil lead concentration less than the PRG. The concept of a RAL is consistent with the adult lead model, which recognizes that the model evaluates exposure on an area wide basis. This means that soils with concentrations exceeding 78,900 mg/kg must be remediated in the "on-site" area to result in an average lead concentration less than 4,601 mg/kg. For the grassy site area (which also includes the wooded areas), the PRG and RAL are 3,195 and 16,700 mg/kg, respectively. The PRG for the Citizens Gas property is 1,840 mg/kg, which is higher than the average soil lead concentration; therefore, no remediation is necessary on the Citizens Gas property.

The complete Baseline Human Health Risk Assessment report is provided as Attachment 2.

5.0 CONCLUSION

Based on the results of the Risk Assessment, risk estimated for arsenic fall within the USEPA target risk range and the total hazard index are all well below 1.0. Based on this analysis, no soil remediation is believed to be necessary for arsenic.

A conclusion of the Baseline Human Health Risk Assessment is that soil remediation is necessary in the "on-site" plant area to remove subsurface soil with total lead concentrations that exceed the calculated RAL of 78,900 mg/kg. Because the exposure scenario assumes a worker who is performing intrusive activities, this standard is being applied to areas with and without pavement.

For the "grass areas", which includes all areas of the site excluding the "on-site" area, the RAL is 16,700 mg/kg for surface soils and no remediation is required for subsurface soils (i.e., soils deeper than 6 inches). Additionally, because the exposure scenario anticipates a non-intrusive use, no removal will be proposed beneath areas of existing pavement. The drainage ditches are considered to be part of the "grass areas" and will therefore be remediated to the 16,700 mg/kg RAL.

Additional sediment sampling is proposed in the drainage ditch that drains around the west side of the Citizens Gas property from the railroad right of way. A description of the proposed sampling is provided in the CMS Activities Summary Report.

ATTACHMENT 1

CORRECTIVE MEASURES STUDY
ACTIVITIES SUMMARY REPORT

Prepared For:

REFINED METALS CORPORATION

Prepared By:

ADVANCED GEOSERVICES CORP.
West Chester, Pennsylvania

Project No. 2003-1046-02
June 22, 2004
Revised October 12, 2004

CORRECTIVE MEASURES STUDY
ACTIVITIES SUMMARY REPORT

Prepared For:

REFINED METALS CORPORATION

Prepared By:

ADVANCED GEOSERVICES CORP.
West Chester, Pennsylvania

Project No. 2003-1046-02
June 22, 2004
Revised October 12, 2004

PROFESSIONAL
PAUL GERARD STRATMAN
No. 2112

Paul G. Stratman, P.G.
P.G. License No. 2112

TABLE OF CONTENTS

LIST OF FIGURES

TABLE OF CONTENTS

(Continued)

LIST OF APPENDICES

APPENDIX

1.0 INTRODUCTION

1.1 GENERAL

This Corrective Measures Study Activities Summary Report has been submitted by Advanced GeoServices Corp. (AGC) on behalf of Refined Metals Corporation (RMC). This report presents and discusses the methods and procedures used to implement the scope of work as proposed in the Phase II RCRA Facility Investigation (RFI) Report. Groundwater monitoring well installation and sampling activities were conducted by AGC. These activities consisted of installing three piezometers and two groundwater monitoring wells, groundwater sampling and sediment sampling at on-site and off-site locations. Laboratory sample analysis was performed by TriMatrix Laboratories Inc. (TriMatrix) of Grand Rapids, Michigan.

The RMC facility was the location of secondary lead smelting operations from 1968 through 1995. RMC was involved in the reclamation of lead from used automotive and industrial batteries and other lead bearing materials. The Site ceased smelting operations on December 31, 1995. Additional background and facility operation can be found in the Phase II RCRA Facility Investigation Report, dated November 18, 2002.

During its operational life, the facility handled materials that were classified as hazardous materials or hazardous wastes under the Resource Conservation and Recovery Act (RCRA). At this time, the Site is idle except for the wastewater treatment system which remains in operation. The wastewater treatment system remains in place to collect and treat stormwater runoff from the lined lagoon and other Site areas.

2.0 WELL INSTALLATION ACTIVITIES

2.1 INTRODUCTION

Background and facility operation information can be found in the Phase II RCRA Facility Investigation Report, dated November 18, 2002. During the Corrective Measures Study (CMS) three temporary piezometers and two groundwater monitoring wells were installed by Boart Longyear, Environmental Division, from Greensberg, Indiana. The three piezometers were installed using a truck mounted Geoprobe in the area north and east of the former manufacturing area. The piezometers were installed for the purpose of refining groundwater flow prior to selection of locations to install two new wells. Geoprobe borings were advanced into the shallow perched groundwater and the piezometer was constructed using a one (1) inch diameter PVC 0.010 screen. The piezometers were constructed on September 4, 2003 as follows:

	Depth of Boring	Depth of Piezometer	Screen Length	GW Elevation 9/05/2003
GP-1	20'	18.0'	15'	837.63
GP-2	15'	14.8'	10'	839.30
GP-3	25'	23.5'	15'	877.89

Groundwater level measurements were taken from the existing monitoring wells north of the former manufacturing area and piezometers on September 5, 2003 and the locations for two new groundwater-monitoring wells were selected.

The two groundwater monitoring wells were installed between September 8-10, 2003 and designated as MW-10 and MW-11. Groundwater monitoring well MW-10 is located east of MW-2 within the wooded area as shown on Figure 2-1. The depth of the boring for MW-10 was recorded to be 36 feet below ground surface (bgs). Groundwater monitoring well MW-11 is located approximately 156 feet east of MW-8 along the fence line of Arlington Avenue. The

depth of the boring for MW-11 was measured at 30 feet bgs. The locations of both wells installed are shown on Figure 2-1.

2.1.1 Drilling Methods

The soil borings were advanced using hollow stem auger (HSA) techniques and continuous split spoon samples were collected in accordance with ASTM D 1586. The logs for the borings and well construction completed as part of this investigation are included in Appendix A. The samples recovered from the advancement of the deep borings were logged and described using USCS soil classification.

2.1.2 Groundwater Monitoring Well Construction

The monitoring wells were constructed using a 4-inch ID, flush-threaded, Schedule 40 PVC riser with a 10-foot length of factory-slotted 0.010-inch PVC well screen. A sand pack was placed to 2 feet above the top of the monitoring well screen with No. 5 sand. A minimum 2-foot thick bentonite seal was placed on top of the sand pack.

All monitoring wells were completed with a steel protective casing with a locking cap. The protective casing extends from an approximate depth of 3 feet bgs to approximately 2 feet above ground. A neat cement seal was placed around the protective casing to a depth of 2.5 to 3 feet bgs. A 2-foot square well pad was installed so that the surface slopes away from the well.

2.1.3 Groundwater Monitoring Well Development Method

Each groundwater monitoring well installed as part of this Corrective Measures Study field activities were developed using the surge-block and pump method. Groundwater monitoring wells were first surged using a plunger-type surge block assembly. This provides the necessary turbulence in and immediately surrounding the well screen to remove fine-grained material. The wells were then purged and developed by continuous pumping using a electric submersible

pump. Well development ceased when the development water in each well was relatively sediment free, exhibited a satisfactory visual clarity and yield.

2.2 GROUNDWATER SAMPLING

2.2.1 Groundwater Well Evacuation

Following the installation of the two additional groundwater monitoring wells, groundwater samples were collected. The sampling event took place on October 26-29, 2003. Groundwater samples were obtained from groundwater monitoring wells MW-1, MW-2, MW-3, MW-4, MW-5, MW-6SR, MW-7, MW-8, MW-9, MW-10 and MW-11. A total of 11 groundwater samples were collected at the Site (excluding QA/QC samples). A low-flow sampling technique was employed to more accurately determine the potential for site-related constituents which may have entered the groundwater.

Each groundwater monitoring well was purged using a stainless steel low-flow bladder pump placed at the midpoint of the screen in each well. The wells were purged at a flow rate ranging from 100 to 300 milliliters per minute mls/min, depending on the yield of the well. A flow-through cell was used to measure the following field parameters: pH, temperature, conductivity, redox potential, and dissolved oxygen prior to contact with oxygen. These parameters were collected at 3 to 5 minute intervals during purging event. Turbidity was also measured at the same time interval. The wells were purged until the field parameters stabilize to within 10% over three readings and pH readings differ by less than 0.1 unit.

2.2.2 Groundwater Sample Collection

Once the field parameters had stabilized, samples were collected directly from the pump discharge line into laboratory-supplied bottles containing the necessary preservatives at a sampling flow rate of 100 to 300 mls/min.

Sample containers were labeled with a unique identifying number, time and date of sample collection, requested analysis, preservative, and the initials of the sample collector. Samples were packed on ice and shipped to TriMatrix Laboratories Inc. for analysis of eight RCRA metals and antimony (SW-846 6010). Samples for dissolved metals analyses were field filtered through a dedicated disposable Nalgene 0.45 μm membrane filter immediately after collection and prior to preservation. The sample was decanted into the dedicated, Nalgene disposable filtration unit and filtered under vacuum pressure created by a hand-held pump. The sample was then immediately transferred to a laboratory supplied bottleware.

3.0 SEDIMENT SAMPLING

Sediment samples were collected from four locations along the drainage ditch running parallel to Arlington Avenue and from six locations along the CSX rail line drainage ditch. The samples collected along the Arlington Avenue drainage ditch were designated R2SED-11 through R2SED-14. The samples collected along the CSX line were designated R2SB25 through R2SB-30. The location of the sediment samples are presented on Figure 3-1. The CMS Work Plan specified collection of two sediment samples from each location at depths of 0 to 6 inches and 6 to 12 inches. Along Arlington Avenue, the samples (designated R2SED-11 through R2SED-14) were collected from the 0 to 6-inch depth and the 6 to 12-inch depth as specified for sediment samples. Along the CSX railroad right-of-way, the samples (designated R2SB25 through R2SB-30) were inadvertently collected following the sample intervals utilized for soil sampling of 0 to 3 inches and 3 to 10 inches. The deviation was not identified until after the completion of sampling activities. The data has been retained and presented in this report, however the results are likely biased towards a higher concentration than the intended sample depths would have produced. This is because off-site sediment impacts from facility operations are likely attributable to stormwater runoff and/or air deposition and because metals are not expected to migrate vertically any applicable distance. For this reason, it is expected that impacts from facility operations would be greater near the surface and would relapse rapidly with depth.

The depth of collection was placed as a suffix to each sample location to delineate in which depth the result is correlated. All sediment samples were collected using decontaminated hand augers. The sediment from each interval was thoroughly homogenized in an aluminum mixing pan and was placed directly into a laboratory supplied jar. Each sediment sample was then placed on ice for shipment and was submitted to TriMatrix to be analyzed for arsenic and lead (EPA Method SW-846 6010B).

4.0 RESULTS

4.1 GROUNDWATER

4.1.1 Groundwater Screening

Arsenic and lead are the two site constituents of concern (COCs) that were detected at levels above the concentrations used for initial groundwater screening purposes. A background concentration was calculated for initial screening of arsenic in groundwater. The background concentrations for arsenic in groundwater has been calculated to be 8.5 µg/l, which is the mean concentration taken from MW-9 plus one standard deviation. The current EPA Region 9 Preliminary Remediation Goals for Tap Water do not provide a standard for lead in groundwater; therefore, we are utilizing the Indiana Department of Environmental Management (IDEM) Residential Default RISC criteria of 15 µg/l. The IDEM Residential Default RISC criteria for arsenic is 50 µg/l.

4.1.2 Groundwater Sampling Results

The analytical results for samples collected from the on-site wells for the groundwater sampling event are presented in Table 4-1. A groundwater surface map is shown as Figure 4-1. October 2003 sample results are provided in Figure 4-2.

Total arsenic was found in groundwater samples at concentrations ranging from 1.3 µg/l in MW-4 to 290 µg/l in MW-7. Arsenic concentrations were detected above the background concentration in MW-1 (24 µg/l), MW-2 (15 µg/l), MW-3 (28 µg/l), MW-5 (8.8 µg/l), MW-7 (290 µg/l), MW-8 (19 µg/l) and MW-10 (24 µg/l). Only MW-7 exceeded the IDEM Residential Default RISC Criteria for arsenic in groundwater.

Total lead was found in groundwater samples at concentrations ranging from below laboratory detection level in MW-1, MW-3, MW-4, MW-10, and MW-11 to 217 μg/l in MW-7. Lead concentrations were detected above the IDEM Residential Default Risk Criteria concentration in MW-2 (44 μg/l), MW-7 (217 μg/l) and MW-8 (55 μg/l). The only filtered sample at or above 15 μgl was MW-8 at a concentration of 15 μgl.

4.2 SEDIMENT

4.2.1 Sediment Screening

Arsenic and lead are the two site constituents of concern (COCs) that were detected at levels above their initial screening levels for soil and sediment. Samples collected from the drainage ditches are referred to as sediment in this report; however, because of the physical character of the material sampled and geomorphic setting, they are compared to the soil standards. The calculated background arsenic in soil concentrations are 10.53 mg/kg for surface soil (0-3 inch) and 7.91 mg/kg (>3 inches) for subsurface soils. Based on the Baseline Human Health Risk Assessment (Attachment 2), the target cleanup level for lead in soil at the Site is 15,916 mg/kg for surface (0-6 inches) soil.

4.2.2 Sediment Sampling Results

The validated analytical results for the sediment samples collected within the drainage ditch along Arlington Avenue and the drainage ditch along the CSX rail line are provided in Table 4-2, and a copy of the validation report is provided in Appendix B.The depth of collection was placed as a suffix to each sample location to delineate to show to which depth the result is correlated.

Concentrations of lead in the samples collected at the depth of 0-3 inches ranged from 617 mg/kg at R2SB25 to 14,800 mg/kg at R2SB29, and concentrations of arsenic ranged from 12 mg/kg at R2SB30 to 169 mg/kg at R2SB26 at this depth. The calculated background concentration for

arsenic was exceeded in all samples. The Baseline Human Health Risk Assessment (HHRA) cleanup level for lead was not exceeded in these samples.

Concentrations of lead in the samples collected at the depth of 0-6 inches ranged from 411 mg/kg at R2SED-12 to 874 mg/kg at R2SED-11, and concentrations of arsenic ranged from 11 mg/kg at R2SED-14 and R2SED-12 to 12 mg/kg at R2SED-11 and R2SED-13 at this depth. Table 4-2 presents lead and arsenic results within this depth interval. The calculated background concentration for arsenic was exceeded in all samples. The HHRA cleanup level for lead was not exceeded in these samples.

Concentrations of lead in the samples collected at the depth of 3-10 inches ranged from 403 mg/kg at R2SB28 to 15,700 mg/kg at R2SB29, and concentrations of arsenic ranged from 9 mg/kg at R2SB30 to 216 mg/kg at R2SB29 at this depth. Table 4-2 presents lead and arsenic results within this depth interval. The calculated background concentration for arsenic was exceeded in all samples. The HHRA cleanup level for lead was not exceeded in these samples.

Concentrations of lead in the samples collected at the depth of 6-12 inches ranged from 24 mg/kg at R2SED-14 to 1,470 mg/kg at R2SED-11, and concentrations of arsenic ranged from 8.3 mg/kg at R2SED-13 to 15 mg/kg at R2SED-11 at this depth. The calculated background concentration for arsenic was exceeded in all samples. The HHRA cleanup level for lead was not exceeded in these samples.

5.0 SUMMARY

The following are drawn from the findings of the Corrective Measures Study activities:

Groundwater

- Thin discontinuous zones of higher permeability glacial soils in (sand) clayey silt and silty clay characterize the shallow zone of saturation.

- Potentiometric groundwater maps for the shallow wells indicate a high point in the vicinity of MW-1. Those maps also show a trough in the groundwater surface oriented north-south through MW-8, MW-6SR and MW-4. The presence of the trough is believed to be the result of the discontinuous semi-confined zones of saturated sand or a groundwater mounded created by periodic standing water in the flat lawn area between the paved manufacturing areas and Arlington Avenue.

- Arsenic concentrations exceeded the calculated background concentration in all but four of the samples tested.

- Lead detected above the IDEM Residential Default RISC Criteria is limited to MW-2S (18 μg/l), MW-7S (217 μg/l) and MW-8S (28 μg/l) immediately north of the manufacturing area where elevated soil lead concentrations exist.

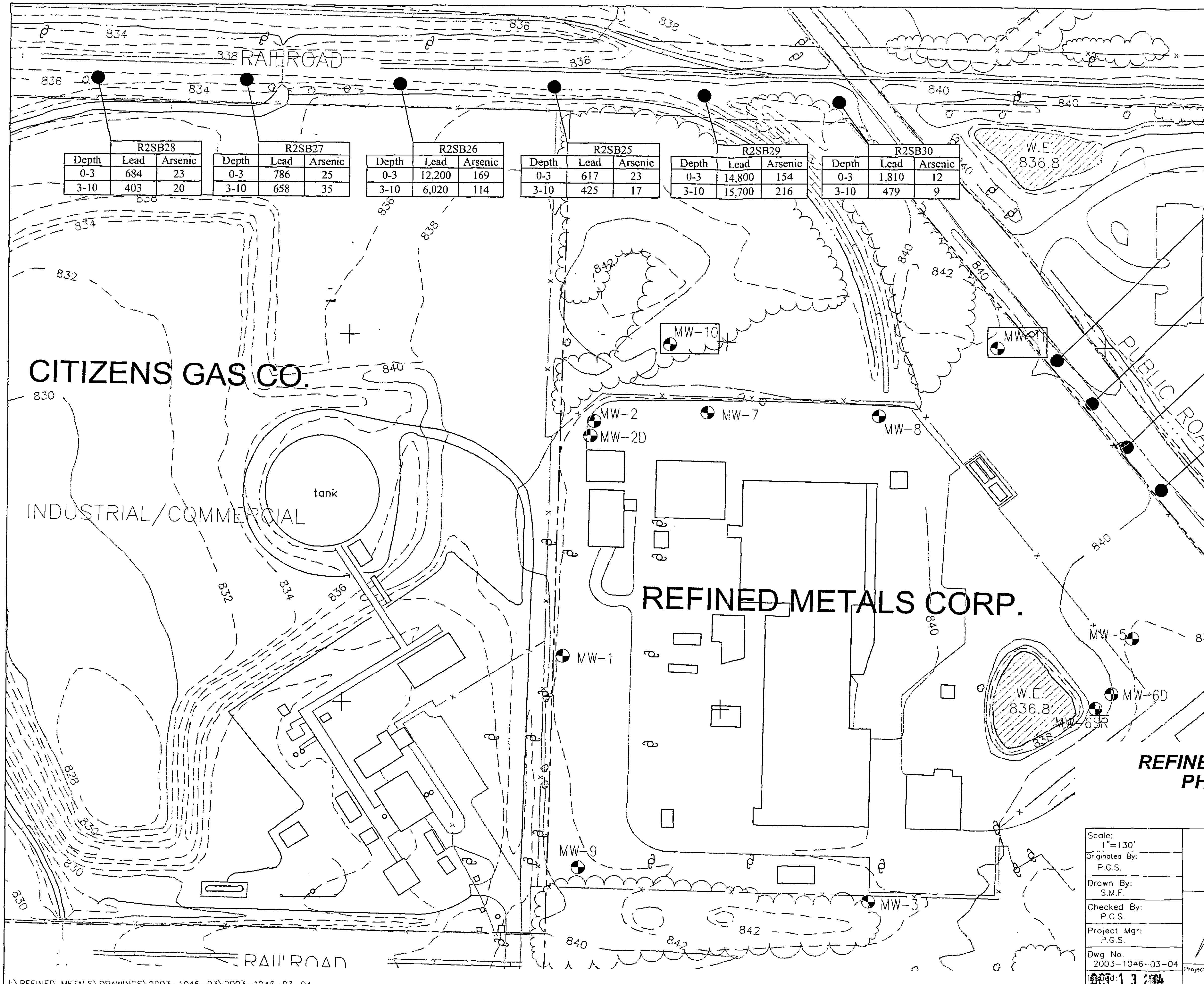
Sediment

- Elevated arsenic in sediment in the drainage ditch along the CSX line northeast of the Site indicate that off-site transport of sediment has probably occurred. To further delineate these impacts, additional sediment samples shall be collected from the drainage channel that begins at the rail road right-of-way between RS2B-26 and RS2B-27 and flows across the Citizens Gas property. Nine (9) additional locations will be sampled. Similar to sediment samples previously collected along the CSX line, the samples will be uniformly distributed at approximately 200 feet on-center. Sampling will be performed following the criteria established for sediment samples in the Phase 2 RFI Work Plan.

- The most downstream sediment samples from the grass lined swale along Arlington Avenue are below 100 mg/kg total lead. Based on this result no additional sampling is proposed along Arlington Avenue.

- All sediment sample results for lead are shown to be below the RAL calculated in the Baseline Human Health Risk Assessment.

FIGURES



R2SB28		
Depth	Lead	Arsenic
0-3	684	23
3-10	403	20

R2SB27		
Depth	Lead	Arsenic
0-3	786	25
3-10	658	35

R2SB26		
Depth	Lead	Arsenic
0-3	12,200	169
3-10	6,020	114

R2SB25		
Depth	Lead	Arsenic
0-3	617	23
3-10	425	17

R2SB29		
Depth	Lead	Arsenic
0-3	14,800	154
3-10	15,700	216

R2SB30		
Depth	Lead	Arsenic
0-3	1,810	12
3-10	479	9

R2SED-14		
Depth	Lead	Arsenic
0-6	681	11
6-12	24	9.5

R2SED-13		
Depth	Lead	Arsenic
0-6	771	12
6-12	28	8.3

R2SED-12		
Depth	Lead	Arsenic
0-6	471	11
6-12	32	9.3

R2SED-11		
Depth	Lead	Arsenic
0-6	874	12
6-12	1,470	15

LEGEND

MW-11 NEWLY CONSTRUCTED MONITORING WELL

MW-8 MONITORING WELL

SEDIMENT SAMPLE LOCATION

NOTE: SEDIMENT ANALYTICAL RESULTS SHOWN IN mg/kg.

REFINED METALS CORPORATION
PHASE I CMS ACTIVITIES
SUMMARY REPORT
BEECH GROVE, INDIANA

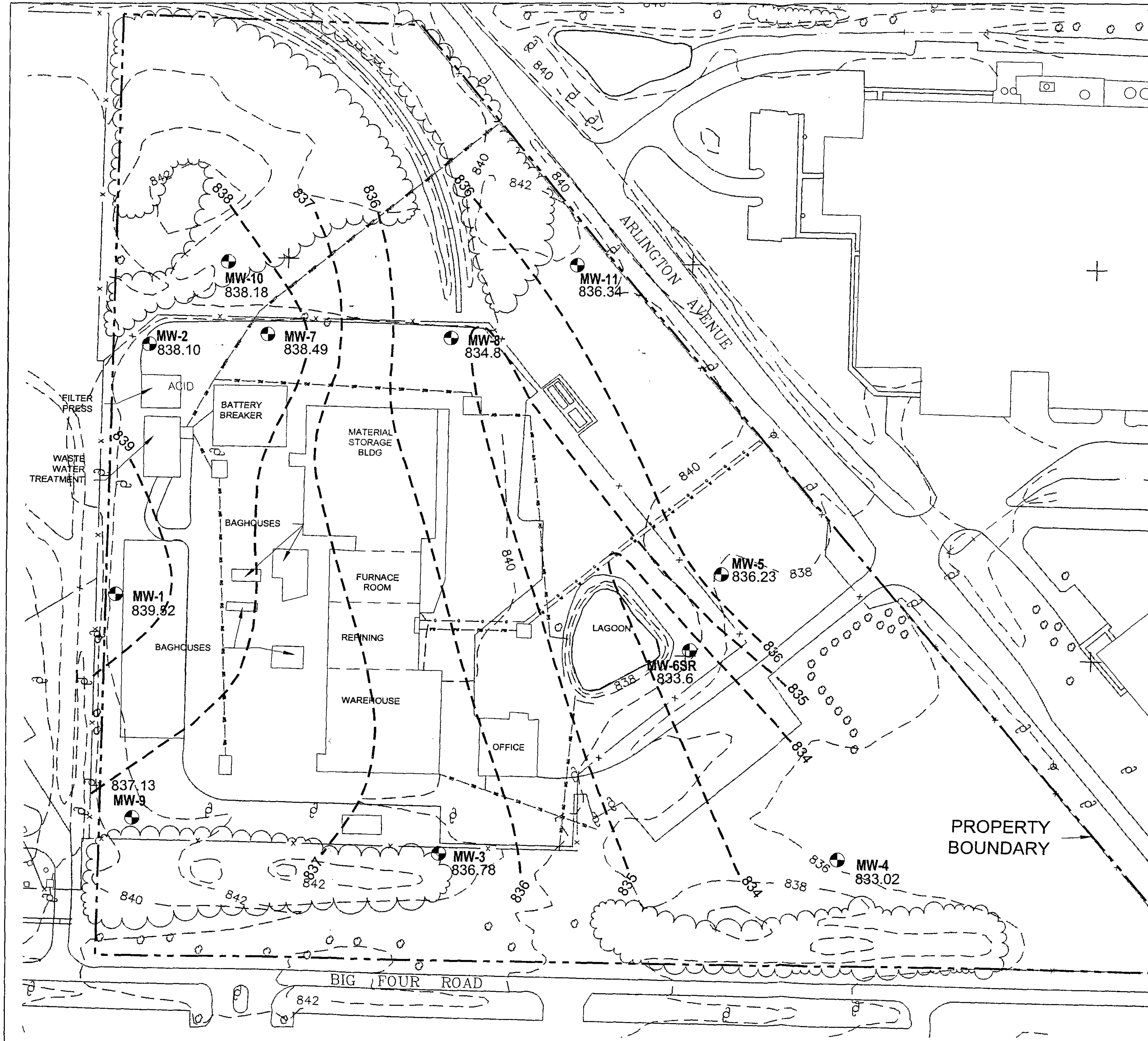
Scale: 1"=130'
Originated By: P.G.S.
Drawn By: S.M.F.
Checked By: P.G.S.
Project Mgr: P.G.S.
Dwg No. 2003-1046-03-04
Issued: OCT 1 3 2004

SEDIMENT SAMPLE RESULTS

Advanced GeoServices Corp.
1055 Andrew Drive Suite A
West Chester, Pennsylvania 19380
(610) 840-9100
FAX: (610) 840-9199

Project No 2003-1046-03

FIGURE: 3-1



N E S W

LEGEND

SHALLOW MONITORING WELL-SURVEYED BY THE SCHNEIDER CORP., INDIANAPOLIS, IN

- - 833 - - POTENTIOMETRIC SURFACE

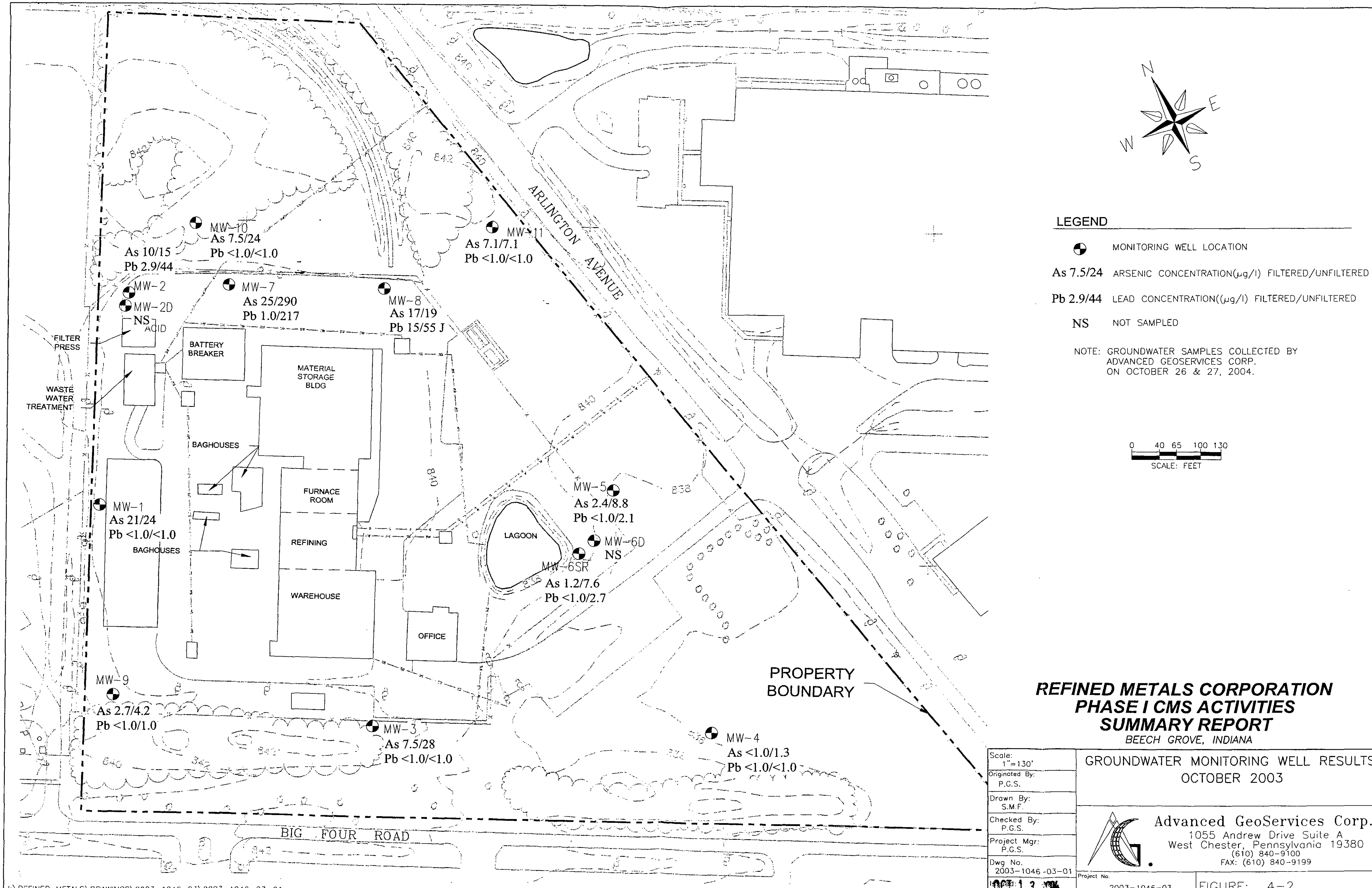
130 0 130 260

SCALE IN FEET

REFINED METALS CORPORATION
SUPPLEMENTAL CLOSURE INVESTIGATION

BEECH GROVE, INDIANA

Scale: 1"=130'	SITE MONITORING WELL LOCATIONS AND SHALLOW GROUNDWATER POTENTIOMETRIC MAP OCTOBER 2003
Originated By: K.M.S.	
Drawn By: P.S.G.	Advanced GeoServices Corp. 1055 Andrew Drive Suite A West Chester, Pennsylvania 19380 (610) 840-9100 FAX: (610) 840-9199
Checked By: P.G.S.	
Project Mgr: P.G.S.	
Dwg No. 2003-1046-03-02	Project No 2003-1046-03
Issue: OCT 1 3 2004	FIGURE: 4-1



MW-10
As 7.5/24
Pb <1.0/<1.0
As 10/15
Pb 2.9/44
MW-2
MW-2D
NS
MW-7
As 25/290
Pb 1.0/217
MW-8
As 17/19
Pb 15/55 J
MW-11
As 7.1/7.1
Pb <1.0/<1.0
ARLINGTON AVENUE
ACID
FILTER PRESS
WASTE WATER TREATMENT
BATTERY BREAKER
MATERIAL STORAGE BLDG
BAGHOUSES
FURNACE ROOM
REFINING
WAREHOUSE
OFFICE
LAGOON
MW-1
As 21/24
Pb <1.0/<1.0
BAGHOUSES
MW-5
As 2.4/8.8
Pb <1.0/2.1
MW-6D
NS
MW-6SR
As 1.2/7.6
Pb <1.0/2.7
MW-9
As 2.7/4.2
Pb <1.0/1.0
MW-3
As 7.5/28
Pb <1.0/<1.0
MW-4
As <1.0/1.3
Pb <1.0/<1.0
PROPERTY BOUNDARY
BIG FOUR ROAD
840
842
838
N
E
S
W
LEGEND
MONITORING WELL LOCATION
As 7.5/24 ARSENIC CONCENTRATION(μg/l) FILTERED/UNFILTERED
Pb 2.9/44 LEAD CONCENTRATION((μg/l) FILTERED/UNFILTERED
NS NOT SAMPLED
NOTE: GROUNDWATER SAMPLES COLLECTED BY ADVANCED GEOSERVICES CORP. ON OCTOBER 26 & 27, 2004.
0 40 65 100 130
SCALE: FEET
REFINED METALS CORPORATION
PHASE I CMS ACTIVITIES
SUMMARY REPORT
BEECH GROVE, INDIANA
Scale: 1"=130'
Originated By: P.G.S.
Drawn By: S.M.F.
Checked By: P.G.S.
Project Mgr: P.G.S.
Dwg No. 2003-1046-03-01
Issued: OCT 13 2004
GROUNDWATER MONITORING WELL RESULTS
OCTOBER 2003
Advanced GeoServices Corp.
1055 Andrew Drive Suite A
West Chester, Pennsylvania 19380
(610) 840-9100
FAX: (610) 840-9199
Project No. 2003-1046-03
FIGURE: 4-2
J:\REFINED METALS\DRAWINGS\2003-1046-03\2003-1046-03-01

APPENDIX A

Geoprobe and Monitoring Well Logs

BOART LONGYEAR — FIELD BORING LOG

Sheet 1 Of 1

FOR: Adv. Geoservices — Refined Metals

LOCATION: Beech Grove IN — Elev.

Job No. 3417-1807-36

Boring No. GP 3

GROUND WATER: While drilling — Before casing removal — After casing removal

Time after drilling — Depth to water — Depth to cave-in

Start 9/9/03

Unit 837

Chief Alan

Casing/Probe Weight — Drop

Sample No.	Moisture	Blows on Sampler 0/6	Blows on Sampler 6/12	Sample Rec.	Total Blows	Depth	VISUAL FIELD CLASSIFICATION AND REMARKS	Depth	Unconfined Strength	Boulders	Blows on Casing Size	Blows on Probe Size	Drilling Method
							Topsoil						6 1/4 H.S.A
							Firm gray-brown mottled silty clay (dry)						
						5		5					
							8.0'						
							Firm brown silty clay with gravel (dry)						
						10		10					
							13.5'						
						15	Stiff gray silty CLAY (moist)	15					
							16.0'						
							Gray sandy clay (wet) 17.0'						
							Stiff gray brown silty clay (dry)						
						20	Same 20.0'	20					
							No Recovery, some sand trapped in sample sleeve. standing water in hole at 18'						
						25	25.0	25					
							EOB 25'						
						30		30					
						35		35					
						40		40					
						45		45					
						50		50					

BOART LONGYEAR

FIELD BORING LOG

Sheet 1 Of 1

FOR Adv. Geoservices Refined Metals

LOCATION Beech Grove IN Elev.

Job No. 3417-1807-36

Boring No. GP 2

GROUND WATER				
While drilling	5.0'	Time after drilling		
Before casing removal	NA	Depth to water		
After casing removal	NA	Depth to cave-in		

Start 9/9/03

Unit 837

Chief Alan

Casing/Probe NA

Weight NA

Drop NA

Sample No.	Moisture	Blows on Sampler 0/6	Blows on Sampler 6/12	Sample Rec.	Total Blows	Depth	VISUAL FIELD CLASSIFICATION AND REMARKS	Depth	Unconfined Strength	Boulders	Blows on Casing Size	Blows on Probe Size	Drilling Method
							Soft dark gray Topsoil 1.0'						6 1/4
							Hard brown/gray mottled silty clay (dry) ~~Clay~~						H.S.A
							becoming ~~wet~~ moist at 3'						
						5	5.0'	5					
							Wet Sand 6.0						
							Stiff tan/brown mottled clay with gravel ~~Same~~						
						10		10					
							~~stiff~~ brown gray mottled clay ~~Sand~~						
							Stiff gray clay with gravel and small cobbles						
						15		15					
							EOB 15'						
						20		20					
						25		25					
						30		30					
						35		35					
						40		40					
						45		45					
						50		50					

FIELD BORING LOG

BOART LONGYEAR

Sheet 1 Of 1

FOR Adv. Geoservices Refined Metals

Job No. 3417-1807-36

LOCATION Beech Grove IN Elev.

Boring No. GP 1

GROUND WATER					
While drilling	13.0'	Time after drilling		Start	9/9/03
Before casing removal	NA	Depth to water		Unit	837
After casing removal	NA	Depth to cave-in	15'	Chief	Alan

Casing/Probe NA
Weight NA
Drop NA

Sample No.	Moisture	Blows on Sampler 0/6	Blows on Sampler 6/12	Sample Rec.	Total Blows	Depth	VISUAL FIELD CLASSIFICATION AND REMARKS	Depth	Unconfined Strength	Boulders	Casing Size	Probe Size	Drilling Method
							Topsoil						~~5 1/4~~
							Soft tan/brown silty ~~Clay~~ Clay (moist)						~~HSA~~ Geop.
						5		5.0'					
							Soft tan/brown to gray silty Clay (with rounded gravel below 6') dry ~~Same~~						
						10		10.5'					
							Gravel and Clay seam (moist) ~~Same~~	10.7'					
							Stiff brown silty Clay with gravel (moist) (wet below 13.0')	▽ 13.0'					
						15		15.2'					
							Brown gray silty ~~Sand~~ Sand (saturated)						
								19.0'					
						20	Hard gray Clay with gravel (dry)	20.0'					
							EOB 20'						
						25							
						30							
						35							
						40							
						45							
						50							

BOART LONGYEAR

FIELD BORING LOG

Sheet 1 Of 1

FOR Adv. Geoservices Refined Metals

Job No. 3417-1807-36

LOCATION Beech Grove IN Elev.

Boring No. MW 10

ROUND WATER: While drilling ___ Before casing removal ___ After casing removal ___

Time after drilling ___ Depth to water ___ Depth to cave-in ___

Start 9/9/03
Unit 822
Chief Dan

Casing/Probe Weight ___ Drop ___

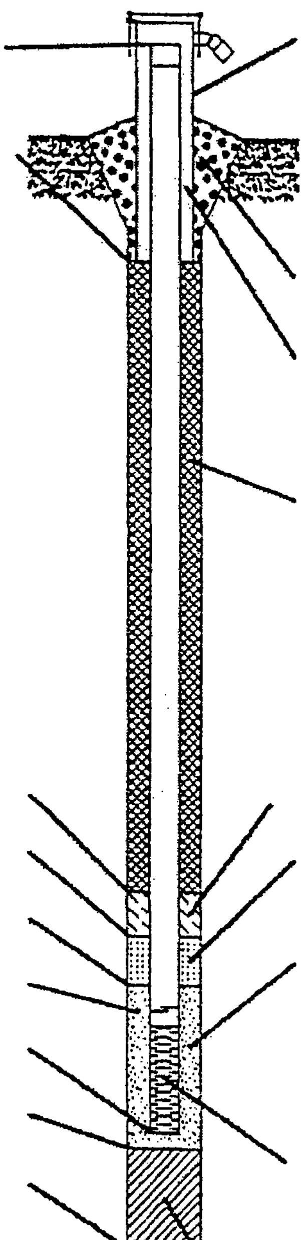
Sample No.	Moisture	Blows on Sampler 0/6	Blows on Sampler 6/12	Sample Rec.	Total Blows	Depth	VISUAL FIELD CLASSIFICATION AND REMARKS	Depth	Unconfined Strength	Boulders	Blows on Casing Size	Blows on Probe Size	Drilling Method
							Topsoil						6 1/4
							Br. Silty Clay						H.S.A
						5		5					
1	D	5	8										
		12	12	2.0	20								
						10	M-C Br. Sand w/ Gravel	10					
2	W	7	34				Gray Silty Clay						
		45	25	1.5	79								
						15		15					
3	W	5	17				Gray Silty Clay						
		43	46	1.5	60								
4	W	10	20										
		25	26	1.2	45								
5	W	10	23			20		20					
		27	30	1.5	60								
6	W	8	10										
		14	16	1.2	24								
							EOB 23'						
						25	Set Well @ 19'	25					
						30		30					
						35		35					
						40		40					
						45		45					
						50		50					

BOART LONGYEAR
Well Construction Report

Job Name: Refined Metals
Job Number: 3417-1807-36
Location: Beech Grove, IN

Well Name: MW-10
Driller: D. Harrison
Helper: ____
Date Installed: 09/09/03

Type of Well:
X Water Table Observation
__ Piezometer
__ Other ____



A. Height of Well Casing above ground 3.0 ft.

B. Diameter of Well Casing 4.0 in.

C. Surface Seal Bottom 1.0 ft.

D. Well Casing: Flush Threaded PVC
X Schedule 40
__ Schedule 80
__ Other ____

E. Bentonite Seal Top 2.0 ft.

F. Fine Sand Top ____ ft.

G. Filter Pack Top 7.0 ft.

H. Screen Joint Top 9.0 ft.

I. Well Bottom 19.0 ft.

J. Filter Pack Bottom 19.0 ft.

K. Borehole Bottom 23.0 ft.

1. Locking Cap? X Yes __ No

2. Protective Cover:
   a. Inside diam. 6.0 in.
   b. Length 5.0 ft.
   c. Material
      X Steel
      __ Other ____
   d. Bumper Post No qty
      __ 3" __ 4"

3. Surface Seal: __ Bentonite
   X Concrete
   __ Other ____

4. Material between Casing and Protop:
   __ Bentonite
   __ Other ____

5. Annular Space Seal:
   __ Granular Bentonite
   __ Bentonite Slurry
   __ Cement-Bentonite Grout
   __ Other ____
   How Installed:
   __ Gravity
   __ Tremie Pumped

6. Bentonite Seal:
   X Granules
   __ Pellets

7. Type of Fine Sand:
   ____

8. Type of Filter Pack:
   #5

9. Screen Material: PVC
   Type: X Factory Cut
   __ Continuous Slot
   Slot Size: 0.010 in.
   Length: 10.0 ft.

10. Backfill Material: (Below filter pack)
   __ None
   X Other Sand

Boart Longyear
5815 Churchman Ave., Suite 2
Indianapolis, IN 46203
Phone (317) 784-1838
Fax (317) 784-2035

FIELD BORING LOG

BOART LONGYEAR — Sheet 1 Of 1

FOR: Adv. Geoservices — Refined Metals

Job No. 3417-1807-36

LOCATION: Beech Grove IN — Elev.

Boring No. MW 11

GROUND WATER: While drilling — Before casing removal — After casing removal

Time after drilling — Depth to water — Depth to cave-in

Start 9/9/03 — Unit 822 — Chief Dan

Casing/Probe Weight — Drop

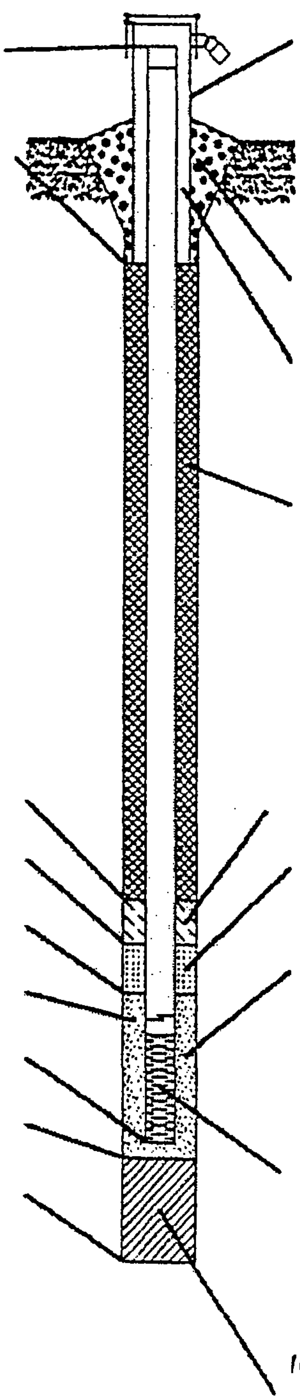
Sample No.	Moisture	Blows on Sampler 0/6	Blows on Sampler 6/12	Sample Rec.	Total Blows	Depth	VISUAL FIELD CLASSIFICATION AND REMARKS	Unconfined Strength	Boulders	Blows on Casing Size	Blows on Probe Size	Drilling Method
							Topsoil					6 1/4
							Br. Silty Clay					H.S.A
						5						
1		8	19									
		42	36	1.8	61							
						10						
2		10	12									
		18	15	1.8	30							
						15						
3		10	24				M-C Sand					
		10	17	1.2	34		Br. Silty Clay					
4		12	17									
		34	75	1.2	51							
5		15	59			20	M-F Br. Silty Sand					
		69	58	1.5	128							
6		15	19				Gray M-F Sand					
		20	23	1.8	39							
							EOB 23'					
						25	Set Well @ 23'					
						30						
						35						
						40						
						45						
						50						

BOART LONGYEAR
Well Construction Report

Job Name: Refined Metals
Job Number: 3417-1807-36
Location: Beech Grove, IN

Well Name: MW-11
Driller: D. Harrison
Helper: ____
Date Installed: 09/09/03

Type of Well:
- X Water Table Observation
- ___ Piezometer
- ___ Other ____



A. Height of Well Casing above ground 3.0 ft.

B. Diameter of Well Casing 4.0 in.

C. Surface Seal Bottom 1.0 ft.

D. Well Casing: Flush Threaded PVC
- X Schedule 40
- ___ Schedule 80
- ___ Other ____

E. Bentonite Seal Top 2.0 ft.

F. Fine Sand Top ____ ft.

G. Filter Pack Top 10.5 ft.

H. Screen Joint Top 13.0 ft.

I. Well Bottom 23.0 ft.

J. Filter Pack Bottom 23.0 ft.

K. Borehole Bottom 23.0 ft.

1. Locking Cap? X Yes ___ No
2. Protective Cover:
   - a. Inside diam. 6.0 in.
   - b. Length 5.0 ft.
   - c. Material
     - X Steel
     - ___ Other ____
   - d. Bumper Post No qty
     - ___ 3" ___ 4"
3. Surface Seal:
   - ___ Bentonite
   - X Concrete
   - ___ Other ____
4. Material between Casing and Protop:
   - ___ Bentonite
   - ___ Other ____
5. Annular Space Seal:
   - ___ Granular Bentonite
   - ___ Bentonite Slurry
   - ___ Cement-Bentonite Grout
   - ___ Other ____

   How Installed:
   - ___ Gravity
   - ___ Tremie Pumped
6. Bentonite Seal:
   - ___ Granules
   - ___ Pellets
7. Type of Fine Sand: ____
8. Type of Filter Pack: #5
9. Screen Material: PVC
   - Type: X Factory Cut / ___ Continuous Slot
   - Slot Size: 0.010 in.
   - Length: 10.0 ft.
10. Backfill Material: (Below filter pack)
    - ___ None
    - ___ Other ____

Boart Longyear
5815 Churchman Ave., Suite 2
Indianapolis, IN 46203
Phone (317) 784-1838
Fax (317) 784-2035

APPENDIX B

Sediment Sampling Data – October 2003 Groundwater Data

TABLE 4-1
Groundwater Sampling,
10/26 - 10/28/2003

Sample Location		MW-4			MW-6			MW-3			MW-3D			MW-5			EB-1-102603			MW-11			MW-7S		
Lab ID		348075			348076			348077			348078			348079			348080			348081			348082		
Sample Date		10/26/2003			10/26/2003			10/26/2003			10/26/2003			10/26/2003			10/26/2003			10/27/2003			10/27/2003		
Matrix		Groundwater			Groundwater			Groundwater			Groundwater			Groundwater			Aqueous			Groundwater			Groundwater		
Remarks											FD of MW-3						Equipment Blank								
Parameter	**Units**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**
Total Metals																									
Antimony	ug/L		U	10		U	10		U	10		U	10		U	10		U	10		U	10		U	10
Arsenic	ug/L	1.3		1	7.6		1	28		1	27		1	8.8		1		U	1	7.1		1	290		1
Barium	ug/L	276		10	228		10	84		10	80		10	159		10		U	10	167		10	17		10
Cadmium	ug/L		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Chromium	ug/L		U	1	4.5		1		U	1		U	1	1.1		1		U	1	1.1		1	1.9		1
Lead	ug/L		U	1	2.7		1		U	1		U	1	2.1		1		U	1		U	1	217		1
Mercury	ug/L		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Selenium	ug/L		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2
Silver	ug/L		U	0.2		U	0.2		U	0.2	0.2		0.2		U	0.2		U	0.2		U	0.2		U	0.2
Dissolved Metals																									
Antimony	ug/L		U	10		U	10		U	10		U	10		U	10		U	10		U	10		U	10
Arsenic	ug/L		U	1	1.2		1	7.5		1	7.7		1	2.4		1		U	1	7.1		1	25		1
Barium	ug/L	213		10	117		10	73		10	76		10	154		10		U	10	167		10	15		10
Cadmium	ug/L		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Chromium	ug/L	2.1		1	2.1		1	4.9		1	4.6		1	2.2		1		U	1		U	1	7.4		1
Lead	ug/L		U	1		U	1		U	1		U	1		U	1		U	1		U	1	1		1
Selenium	ug/L		U	2		U	2	2		2		U	2		U	2		U	2		U	2		U	2

F:\OFICEAGC\PROJECTS\Files\2003-1046\Reports\Corrective Measures\Table 4-1

TABLE 4-1
Groundwater Sampling,
10/26 - 10/28/2003

Sample Location		MW-9			MW-1			MW-2			FB-1-102703			MW-10			MW-8S			MW-8SD			EB-2-102803		
Lab ID		348083			348084			348085			348086			348087			348088			348089			348090		
Sample Date		10/27/2003			10/27/2003			10/27/2003			10/27/2003			10/28/2003			10/28/2003			10/28/2003			10/28/2003		
Matrix		Groundwater			Groundwater			Groundwater			Aqueous			Groundwater			Groundwater			Groundwater			Aqueous		
Remarks											Field Blank									FD of MW-8S			Equipment Blank		
Parameter	**Units**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**
Total Metals																									
Antimony	ug/L		U	10		U	10		U	10		U	10		U	10		U	10		U	10		U	10
Arsenic	ug/L	4.2		1	24		1	15		1		U	1	24		1	19		1	18		1		U	1
Barium	ug/L	43		10	69		10	44		10		U	10	71		10	89		10	83		10		U	10
Cadmium	ug/L		U	0.2		U	0.2	0.2		0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Chromium	ug/L		U	1	1.3		1	2.1		1		U	1	1.6	U	1	1.1	U	1	1.5	U	1	1.2		1
Lead	ug/L	1		1		U	1	44		1		U	1		U	1	55	J	1	35	J	1		U	1
Mercury	ug/L		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Selenium	ug/L		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2
Silver	ug/L		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Dissolved Metals																									
Antimony	ug/L		U	10		U	10		U	10		U	10		U	10		U	10		U	10		U	10
Arsenic	ug/L	2.7		1	21		1	10		1		U	1	7.5		1	17		1	16		1		U	1
Barium	ug/L	41		10	69		10	22		10		U	10	16		10	79		10	76		10		U	10
Cadmium	ug/L		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Chromium	ug/L	1.9		1	6.5		1	3.1		1		U	1	5.2		1	2.9		1	2.8		1		U	1
Lead	ug/L		U	1		U	1	2.9		1		U	1		U	1	15		1	12		1		U	1
Selenium	ug/L		U	2		U	2		U	2		U	2	2.3		2		U	2		U	2		U	2

TABLE 4-2
Sediment Sampling,
10/28 - 10/29/2003

Sample Location	Lab ID	Sample Date	Matrix	Remarks	Parameter	Units	Result	Q	RL
Arsenic									
R2SED-11-0-6	348091	10/28/2003	Sediment		Arsenic	mg/kg	12		1
R2SED-11-6-12	348092	10/28/2003	Sediment		Arsenic	mg/kg	15		1
R2SED-12-0-6	348093	10/28/2003	Sediment		Arsenic	mg/kg	11		1
R2SED-12D-0-6	348094	10/28/2003	Sediment	FD of R2SED-12-0-6	Arsenic	mg/kg	12		1
R2SED-12-6-12	348095	10/28/2003	Sediment		Arsenic	mg/kg	9.3		1
R2SED-13-0-6	348096	10/28/2003	Sediment		Arsenic	mg/kg	12		1
R2SED-13-6-12	348097	10/28/2003	Sediment		Arsenic	mg/kg	8.3		1
R2SED-14-0-6	348098	10/28/2003	Sediment		Arsenic	mg/kg	11		1
R2SED-14-6-12	348099	10/28/2003	Sediment		Arsenic	mg/kg	9.5		1
R2SB30-0-3	348101	10/29/2003	Sediment		Arsenic	mg/kg	12		1
R2SB30-3-10	348102	10/29/2003	Sediment		Arsenic	mg/kg	9		1
R2SB29-0-3	348103	10/29/2003	Sediment		Arsenic	mg/kg	154		25
R2SB29-3-10	348104	10/29/2003	Sediment		Arsenic	mg/kg	216		25
R2SB25-0-3	348105	10/29/2003	Sediment		Arsenic	mg/kg	23		1
R2SB25-3-10	348106	10/29/2003	Sediment		Arsenic	mg/kg	17		1
R2SB26-0-3	348107	10/29/2003	Sediment		Arsenic	mg/kg	169		25
R2SB26-3-10	348108	10/29/2003	Sediment		Arsenic	mg/kg	114		25
R2SB27-0-3	348109	10/29/2003	Sediment		Arsenic	mg/kg	25		1
R2SB27-3-10	348110	10/29/2003	Sediment		Arsenic	mg/kg	35		1
R2SB28-0-3	348111	10/29/2003	Sediment		Arsenic	mg/kg	23		1
R2SB28-3-10	348112	10/29/2003	Sediment		Arsenic	mg/kg	20		1
R2SB28D-3-10	348113	10/29/2003	Sediment	FD of R2SB28-3-10	Arsenic	mg/kg	22		1
EB-4-102903	348114	10/29/2003	Aqueous	Equipment Blank	Arsenic	ug/L		U	1
Lead									
R2SED-11-0-6	348091	10/28/2003	Sediment		Lead	mg/kg	874		120
R2SED-11-6-12	348092	10/28/2003	Sediment		Lead	mg/kg	1470		300
R2SED-12-0-6	348093	10/28/2003	Sediment		Lead	mg/kg	411		60
R2SED-12D-0-6	348094	10/28/2003	Sediment	FD of R2SED-12-0-6	Lead	mg/kg	462		60
R2SED-12-6-12	348095	10/28/2003	Sediment		Lead	mg/kg	32		0.6
R2SED-13-0-6	348096	10/28/2003	Sediment		Lead	mg/kg	771		120
R2SED-13-6-12	348097	10/28/2003	Sediment		Lead	mg/kg	28		0.6
R2SED-14-0-6	348098	10/28/2003	Sediment		Lead	mg/kg	681		60
R2SED-14-6-12	348099	10/28/2003	Sediment		Lead	mg/kg	24		0.6
R2SB30-0-3	348101	10/29/2003	Sediment		Lead	mg/kg	1810		300
R2SB30-3-10	348102	10/29/2003	Sediment		Lead	mg/kg	479		60
R2SB29-0-3	348103	10/29/2003	Sediment		Lead	mg/kg	14800		3000
R2SB29-3-10	348104	10/29/2003	Sediment		Lead	mg/kg	15700		3000
R2SB25-0-3	348105	10/29/2003	Sediment		Lead	mg/kg	617		60
R2SB25-3-10	348106	10/29/2003	Sediment		Lead	mg/kg	425		60
R2SB26-0-3	348107	10/29/2003	Sediment		Lead	mg/kg	12200		1200
R2SB26-3-10	348108	10/29/2003	Sediment		Lead	mg/kg	6020		600
R2SB27-0-3	348109	10/29/2003	Sediment		Lead	mg/kg	786		120
R2SB27-3-10	348110	10/29/2003	Sediment		Lead	mg/kg	658		120
R2SB28-0-3	348111	10/29/2003	Sediment		Lead	mg/kg	684		120
R2SB28-3-10	348112	10/29/2003	Sediment		Lead	mg/kg	403		60
R2SB28D-3-10	348113	10/29/2003	Sediment	FD of R2SB28-3-10	Lead	mg/kg	490		60
EB-4-102903	348114	10/29/2003	Aqueous	Equipment Blank	Lead	ug/L		U	1

Well ID: MW-1 Job No: 98-478-04

Date Sampled: 10/27/2003

Sampled by: BAC

Well Diameter: 2"

DTW: 7.47

DTB: 31.56

Estimated Pump Setting: 26'

Estimated Flow Rate: 140 ml/min

Sample Collection Time: 1412

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1257	6.74	5.40	1.325	12.95	134	195.0
1300	6.79	2.62	1.51	12.66	107	340
1303	6.79	1.93	1.55	12.84	81	385
1307	6.79	1.34	1.55	13.57	58	476
1310	6.78	1.20	1.55	13.70	52	403
1314	6.79	0.87	1.54	13.73	40	270
1318	6.79	0.74	1.55	13.76	32	152.3
1321	6.79	0.67	1.54	13.55	27	98.9
1324	6.79	0.66	1.55	13.58	25	79.0
1327	6.79	0.62	1.55	13.54	21	64.8
1330	6.79	0.59	1.55	13.63	18	51.6
1333	6.79	0.57	1.55	13.67	15	47.3
1336	6.78	0.56	1.55	13.76	13	39.0
1339	6.78	0.53	1.55	13.75	11	33.6
1342	6.79	0.52	1.55	14.00	10	28.4
1345	6.79	0.52	1.55	14.06	8	20.3
1348	6.78	0.49	1.56	14.48	-3	17.5
1400	6.78	0.48	1.56	14.38	-3	15.4
1403	6.79	0.48	1.55	13.84	-5	15.2
1406	6.78	0.47	1.56	13.92	-5	14.8
1409	6.78	0.46	1.56	14.30	-6	14.2
1416	6.81	1.58	1.56	13.98	74	28.5

Comment: 3.0 gal removed

Well ID: MW-2 Job No: 98-478-04

Date Sampled: 10/27/2003

Sampled by: BAC

Well Diameter: 2"

DTW: 8.8

DTB: 31.36

Estimated Pump Setting: 26'

Estimated Flow Rate: 180 ml/min

Sample Collection Time: 1540

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1438	6.72	3.08	1.90	14.58	60	83.9
1441	6.72	1.75	1.91	14.14	47	88.1
1444	6.71	1.50	1.90	13.70	44	93.9
1448	6.70	1.11	1.89	14.61	35	58.7
1451	6.70	1.05	1.90	14.78	34	53.3
1454	6.70	0.95	1.91	15.19	28	44.7
1458	6.71	0.84	1.92	15.06	21	30.3
1502	6.71	0.75	1.92	14.46	15	21.6
1506	6.71	0.70	1.93	14.44	12	17.8
1509	6.71	0.68	1.93	14.33	10	15.1
1512	6.72	0.66	1.93	14.38	9	13.6
1515	6.72	0.65	1.93	14.43	8	12.2
1518	6.71	0.64	1.93	14.48	7	11.1
1521	6.71	0.62	1.93	14.28	5	9.8
1524	6.71	0.61	1.93	14.29	4	9.6
1527	6.72	0.59	1.93	13.91	2	8.4
1530	6.72	0.58	1.94	13.94	2	8.1
1533	6.71	0.58	1.93	13.97	1	8.0
1546	6.71	1.03	1.91	14.70	62	15.3

Comment: 3.0 gal removed

Well ID: MW-3 Job No: 98-478-04

Date Sampled: 10/26/2003

Sampled by: BAC

Well Diameter: 2"

DTW: 11.28

DTB: 22.36

Estimated Pump Setting: 17'

Estimated Flow Rate: 210 ml/min

Sample Collection Time: 1415

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1312	6.97	2.84	1.367	13.40	101	962
1315	6.95	1.62	1.389	13.82	88	957
1318	6.94	1.11	1.389	13.96	76	1058
1321	6.93	1.17	1.389	13.90	74	1108
1325	6.95	0.87	1.391	13.95	67	838
1330	6.94	0.75	1.392	13.77	56	536
1334	6.94	0.77	1.392	13.57	52	366
1337	6.95	0.74	1.392	13.46	51	362
1340	6.94	0.70	1.391	13.27	46	277
1343	6.95	0.70	1.391	13.24	46	291
1346	6.95	0.65	1.390	13.19	42	261
1349	6.96	0.64	1.390	13.16	40	179.1
1352	6.96	0.64	1.389	13.33	38	171.3
1355	6.96	0.65	1.387	13.29	36	173.8
1358	6.95	0.66	1.386	13.87	36	137.8
1401	6.96	0.65	1.387	13.87	34	122.9
1404	6.95	0.59	1.387	13.38	31	92.7
1407	6.95	0.57	1.388	13.36	28	82.1
1410	6.96	0.56	1.388	13.35	26	90.3
1413	6.96	0.54	1.389	13.39	25	84.1

Comment: Removed 3.0 gal

Well ID: MW-4 Job No: 98-478-04

Date Sampled: 10/26/2003

Sampled by: BAC

Well Diameter: 2"

DTW: 6

DTB: 23.97

Estimated Pump Setting: 19'

Estimated Flow Rate: 200ml/min

Sample Collection Time: 1130

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1024	7.02	3.96	0.806	14.11	365	1149
1028	7.03	1.67	0.814	14.71	283	668
1032	7.03	1.26	0.816	14.40	189	473
1036	7.02	1.14	0.814	14.02	125	447
1040	7.02	1.09	0.814	14.13	107	380
1044	7.01	1.01	0.816	14.36	89	310
1048	7.00	0.94	0.817	14.54	78	233
1052	7.00	0.89	0.819	14.36	73	128.9
1056	7.00	0.85	0.820	14.45	69	127.6
1100	7.00	0.81	0.821	14.35	65	185.3
1104	7.00	0.78	0.821	14.73	61	178.6
1108	7.00	0.75	0.822	14.61	60	261.0
1112	6.99	0.73	0.824	14.62	55	120.6
1116	6.99	0.68	0.825	14.97	52	91.6
1120	7.00	0.66	0.825	14.7	48	61.7
1123	6.99	0.65	0.825	14.53	47	52.9
1126	6.99	0.62	0.826	14.82	45	55.8
1129	6.98	0.61	0.827	15.07	44	54.4

Commen Removed 3.0 gal

Well ID: MW-5 Job No: 98-478-04

Date Sampled: 10/26/2003

Sampled by: BAC

Well Diameter: 2"

DTW: 4.61

DTB: 26.25

Estimated Pump Setting: 21'

Estimated Flow Rate: 170 ml/min

Sample Collection Time: 1612

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	μS/cm	°C	mV	NTU
1445	7.16	4.15	0.759	13.29	178	413
1448	7.10	2.99	0.768	13.55	159	531
1451	7.09	2.17	0.777	13.54	150	603
1454	7.08	1.47	0.782	13.53	146	568
1457	7.09	1.39	0.781	13.52	145	406
1501	7.09	1.25	0.781	13.68	146	216
1505	7.09	1.20	0.783	13.75	145	142.1
1509	7.09	0.96	0.791	13.64	140	640
1513	7.08	0.93	0.790	13.60	140	529
1516	7.07	0.89	0.791	13.44	139	244
1519	7.07	0.87	0.791	13.35	138	151.5
1522	7.08	0.81	0.791	13.21	134	89.7
1525	7.07	0.77	0.791	13.09	131	125.0
1528	7.06	0.75	0.792	12.99	128	149.3
1531	7.07	0.72	0.792	12.98	126	295
1534	7.07	0.71	0.792	12.85	124	226
1537	7.08	0.71	0.792	12.65	123	118.3
1540	7.07	0.71	0.791	12.50	121	110.6
1543	7.07	0.70	0.793	12.41	120	64.7
1547	7.07	0.67	0.794	12.10	115	46.8
1551	7.07	0.66	0.795	12.08	115	38.8
1555	7.07	0.65	0.794	12.12	112	28.0
1600	7.08	0.65	0.795	12.10	110	26.1
1603	7.07	0.65	0.793	12.09	110	21.3
1606	7.08	0.64	0.793	12.20	109	20.8
1609	7.08	0.62	0.793	12.30	107	19.9
1615	7.08	1.81	0.806	13.03	167	65.3

Comment: 4.0 gal removed

Well ID: MW-6 Job No: 98-478-04

Date Sampled: 10/26/2003

Sampled by: BAC

Well Diameter: 4"

DTW: 11.65

DTB: 31.8

Estimated Pump Setting: 27'

Estimated Flow Rate: 160 ml/min

Sample Collection Time: 1244

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1149	7.19	4.14	0.884	14.07	194	184.4
1152	7.18	3.36	0.889	13.59	171	142.0
1155	7.19	2.88	0.889	13.00	153	127.5
1159	7.22	2.30	0.879	13.05	128	110.0
1203	7.22	2.03	0.877	13.56	122	119.3
1207	7.24	1.38	0.870	13.71	98	117.9
1211	7.26	1.19	0.866	13.04	83	102.9
1214	7.27	1.12	0.865	13.10	80	101.4
1217	7.25	1.08	0.867	13.21	78	104.5
1220	7.24	1.05	0.874	13.18	76	114.7
1223	7.18	1.00	0.882	13.50	73	130.2
1226	7.18	0.90	0.884	13.47	71	132.1
1229	7.19	0.84	0.878	13.24	68	125.6
1232	7.20	0.80	0.875	13.11	65	118.6
1235	7.20	0.78	0.876	13.12	64	117.0
1238	7.21	0.76	0.873	13.12	63	114.6
1241	7.20	0.76	0.878	12.97	62	115.6
1250	7.21	1.03	0.863	13.34	135	135.6

Comment: Removed 2.5 gal

Well ID: MW-7 Job No: 98-478-04

Date Sampled: 10/27/2003

Sampled by: BAC

Well Diameter: 4"

DTW: 6.12

DTB: 24.62

Estimated Pump Setting: 19'

Estimated Flow Rate: 210 ml/min

Sample Collection Time: 1110

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1000	6.44	1.91	4.19	14.94	157	132.5
1003	6.44	1.11	4.20	15.19	126	144.2
1006	6.43	1.08	4.19	14.85	119	145.7
1010	6.43	0.98	4.18	14.98	112	166.2
1014	6.44	0.84	4.12	15.08	103	265
1018	6.44	0.84	4.10	14.81	98	304
1022	6.45	0.82	4.06	14.52	92	376
1026	6.45	0.76	4.04	15.21	88	456
1029	6.45	0.70	3.98	15.21	82	490
1032	6.45	0.65	3.95	15.43	76	522
1035	6.46	0.64	3.95	15.40	75	516
1038	6.46	0.64	3.94	15.24	73	502
1041	6.46	0.63	3.95	15.28	69	481
1044	6.46	0.63	3.93	15.37	67	440
1047	6.46	0.60	3.92	15.53	63	405
1050	6.46	0.60	3.92	15.31	60	366
1053	6.46	0.59	3.92	14.83	58	343
1056	6.46	0.58	3.92	14.69	55	312
1059	6.46	0.56	3.93	14.71	52	293
1102	6.46	0.55	3.92	15.07	50	254
1105	6.46	0.55	3.91	14.99	49	248
1108	6.46	0.54	3.92	15.03	47	242
1115	6.46	0.67	3.91	15.45	43	136.7

Comment: 4.0 gal removed

Well ID: MW-8

Job No: 98-478-04

Date Sampled: 10/28/2003

Sampled by: BAC

Well Diameter: 4"

DTW: 8.75

DTB: 29.18

Estimated Pump Setting: 24'

Estimated Flow Rate: 190 ml/min

Sample Collection Time: 1040

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
954	7.26	2.13	1.097	14.09	16	25.3
957	7.24	1.55	1.080	14.12	23	18.0
1000	7.25	1.43	1.079	13.59	30	15.5
1003	7.25	1.31	1.076	14.05	34	12.6
1006	7.25	1.22	1.075	14.02	38	12.3
1010	7.27	1.11	1.074	14.05	41	11.6
1014	7.27	1.10	1.072	14.04	42	11.1
1018	7.26	1.03	1.058	14.06	44	9.3
1022	7.25	1.02	1.058	14.09	45	9.4
1025	7.26	0.98	1.051	13.97	45	8.9
1028	7.25	0.98	1.046	14.01	46	8.4
1031	7.23	0.92	1.033	14.12	45	6.9
1034	7.23	0.91	1.028	14.04	45	7.0
1037	7.23	0.91	1.028	13.88	45	6.9

Comment: 2.0 gal removed

Well ID: MW-9 Job No: 98-478-04

Date Sampled: 10/27/2003

Sampled by: BAC

Well Diameter: 4"

DTW: 9.74

DTB: 28.05

Estimated Pump Setting: 23"

Estimated Flow Rate: 150 ml/min

Sample Collection Time: 1220

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1137	7.02	3.21	1.004	11.73	97	31.5
1140	6.98	1.57	0.991	12.20	75	14.5
1143	6.97	1.15	0.990	12.23	62	15.0
1147	6.97	1.18	0.991	12.06	53	12.1
1151	6.97	1.15	0.991	12.05	52	13.1
1155	6.97	1.06	0.990	12.26	50	13.1
1159	6.97	0.99	0.989	12.40	50	13.7
1202	6.97	0.94	0.988	12.54	50	11.9
1205	6.97	0.91	0.987	12.61	51	13.1
1208	6.97	0.80	0.984	13.01	52	10.9
1212	6.96	0.75	0.975	13.52	56	8.8
1215	6.97	0.74	0.972	13.10	56	8.3
1218	6.97	0.70	0.967	13.52	56	7.9
1231	7.08	1.27	0.876	13.48	122	5.8

Comment: 2.0 gal removed

Well ID: MW-10 Job No: 98-478-04

Date Sampled: 10/28/2003

Sampled by: BAC

Well Diameter: 4"

DTW: 5.36

DTB: 22.08

Estimated Pump Setting: 17'

Estimated Flow Rate: 180 ml/min

Sample Collection Time: 920

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
831	6.65	6.35	6.58	8.75	286	23.8
834	6.75	2.31	7.59	10.31	252	13.9
837	6.74	1.42	7.57	9.83	170	13.5
840	6.74	1.34	7.54	9.74	166	13.4
844	6.74	1.19	7.49	9.88	139	16.5
848	6.73	1.06	7.29	10.08	116	20.7
851	6.73	1.03	7.18	10.14	111	18.3
854	6.73	0.96	7.07	10.20	105	18.5
857	6.73	0.90	6.97	10.02	98	19.4
900	6.73	0.88	6.92	10.00	95	18.7
903	6.73	0.84	6.89	9.99	87	18.5
906	6.73	0.82	6.87	10.01	85	17.8
909	6.73	0.81	6.78	9.95	80	16.9
912	6.73	0.77	6.77	10.14	73	16.8
915	6.73	0.76	6.73	10.22	69	16.3
918	6.73	0.74	6.69	10.23	68	15.8
923	6.73	0.83	6.55	10.72	64	25

Comment: 2.5 gal removed

Well ID: MW-11 Job No: 98-478-04

Date Sampled: 10/27/2003

Sampled by: BAC

Well Diameter: 4"

DTW: 9.75

DTB: 26.2

Estimated Pump Setting: 21'

Estimated Flow Rate: 210 ml/min

Sample Collection Time: 915

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
834	7.04	3.73	1.088	10.58	287	49.3
837	7.08	2.21	1.105	11.31	236	9.1
840	7.10	1.52	1.108	11.26	200	6.5
843	7.11	1.36	1.109	10.61	167	6.7
846	7.10	1.28	1.110	10.90	138	5.4
849	7.10	1.13	1.110	10.97	109	5.3
852	7.09	1.08	1.111	11.06	101	5.0
855	7.09	0.96	1.111	11.09	82	4.9
858	7.09	0.90	1.112	11.13	71	4.9
901	7.09	0.84	1.114	11.19	57	4.1
904	7.08	0.83	1.114	11.14	50	4.0
907	7.08	0.77	1.115	11.15	45	3.9
910	7.08	0.76	1.115	11.16	43	3.6
913	7.06	0.74	1.116	11.17	41	3.1
917	7.04	0.87	1.117	12.04	34	6.2

Comment: 2.5 gal removed

INORGANIC DATA VALIDATION SUMMARY

Site Name: RMC Beechgrove
Project Number: ~~98-478-04~~ 2003-1046-03
Sampling Date(s): 10/28-29/2003

Laboratory: Trimatrix
Case /Order No.: 35132-35

Compound List: ☐ TAL ☐ Priority Pollutant ☐ Appendix IX ☑ Other As & Pb

Method: ☐ CLP SOW ILMO4. ☐ 40 CFR 136 ☑ SW-846 Method 6020 ☐ Other ______

The following table indicates the data validation criteria examined, any problems identified, and the QA action applied.

Data Validation Criteria:	accept	FYI	qualify	Comments
Holding Times	✓			
Initial Calibrations	✓			
Continuing Calibrations	✓			
CRDL Standards	✓			
Blank Analysis Results		✓		
ICP Interference Check Sample Recoveries	✓			
Duplicate Results	✓			
Field Duplicate Results	✓			
Spike Analysis Recoveries	✓			
Serial Dilution Results				NA
Laboratory Control Sample Results	✓			
Furnace AA QC Analysis				NA
Quantitation/Detection Limits	✓			
Overall Assessment of Data	✓			
Other:				

General Comments: ______

Accept - No qualification required.
FYI - For your information only, no qualification necessary.
Qualify - Qualify as rejected, estimated or biased
NA - Not applicable.
NR - Not reviewed.

QA Scientist Jerry M Stanton
Date 1/9/2004

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client: Advanced GeoServices Corporation
Project: RMC - Beech Grove, IN

Sampled: 10/28/03 @ 12:20
Sampler:
Received: 10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R2SED-11-0-6
Sample #: 348091
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	12	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	874	120	mg/kg dry	11/13/03	DSC	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/28/03 @ 12:30
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R2SED-11-6-12
Sample #: 348092
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	15	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	1470	300	mg/kg dry	11/13/03	DSC	USEPA-6020

MB 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

ANALYTICAL REPORT

Client: Advanced GeoServices Corporation
Project: RMC - Beech Grove, IN

Sampled: 10/28/03 @ 12:45
Sampler:
Received: 10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R2SED-12-0-6
Sample #: 348093
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	11	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	411	60	mg/kg dry	11/13/03	DSC	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client: Advanced GeoServices Corporation
Project: RMC - Beech Grove, IN

Sampled: 10/28/03 @ 12:50
Sampler:
Received: 10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R2SED-12D-0-6
Sample #: 348094
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	12	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	462	60	mg/kg dry	11/13/03	DSC	USEPA-6020

JMB 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/28/03 @ 12:55
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R2SED-12-6-12
Sample #: 348095
Matrix: Soil/Solid   Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	9.3	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	32	0.60	mg/kg dry	11/11/03	JMF	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/28/03 @ 13:05
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R2SED-13-0-6
Sample #: 348096
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	12	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	771	120	mg/kg dry	11/13/03	DSC	USEPA-6020

JMB 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/28/03 @ 13:20
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R2SED-13-6-12
Sample #: 348097
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	8.3	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	28	0.60	mg/kg dry	11/11/03	JMF	USEPA-6020

jmb 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/28/03 @ 13:40
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R2SED-14-0-6
Sample #: 348098
Matrix: Soil/Solid　　　Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	11	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	681	60	mg/kg dry	11/13/03	DSC	USEPA-6020

JMB 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/28/03 @ 13:55
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R2SED-14-6-12
Sample #: 348099
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	9.5	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	24	0.60	mg/kg dry	11/11/03	JMF	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client: Advanced GeoServices Corporation
Project: RMC - Beech Grove, IN

Sampled: 10/28/03 @ 14:20
Sampler:
Received: 10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: EB-3-102803
Sample #: 348100
Matrix: QC Water

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	<1.0	1.0	ug/L	11/12/03	MSG	EPA-200.8/6020
Lead, Total	<1.0	1.0	ug/L	11/12/03	MSG	EPA-200.8/6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client: Advanced GeoServices Corporation
Project: RMC - Beech Grove, IN

Sampled: 10/29/03 @ 08:45
Sampler:
Received: 10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B30-0-3
Sample #: 348101
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	12	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	1810	300	mg/kg dry	11/13/03	DSC	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client: Advanced GeoServices Corporation
Project: RMC - Beech Grove, IN

Sampled: 10/29/03 @ 08:50
Sampler:
Received: 10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B30-3- 10
Sample #: 348102
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	9.0	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	479	60	mg/kg dry	11/13/03	DSC	USEPA-6020

JMB 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/29/03 @ 09:10
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B29-0-3
Sample #: 348103
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	154	25	mg/kg dry	11/13/03	DSC	USEPA-6020
Lead, Total	14800	3000	mg/kg dry	11/13/03	DSC	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/29/03 @ 09:15
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B29-3- 10
Sample #: 348104
Matrix: Soil/Solid　　　Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	216	25	mg/kg dry	11/13/03	DSC	USEPA-6020
Lead, Total	15700	3000	mg/kg dry	11/13/03	DSC	USEPA-6020

JMB 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/29/03 @ 09:40
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B25-0-3
Sample #: 348105
Matrix: Soil/Solid   Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	23	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	617	60	mg/kg dry	11/13/03	DSC	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

ANALYTICAL REPORT

Client: Advanced GeoServices Corporation
Project: RMC - Beech Grove, IN

Sampled: 10/29/03 @ 09:50
Sampler:
Received: 10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B25-3- 10
Sample #: 348106
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	17	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	425	60	mg/kg dry	11/13/03	DSC	USEPA-6020

JMB 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/29/03 @ 10:10
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B26-0-3
Sample #: 348107
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	169	25	mg/kg dry	11/13/03	DSC	USEPA-6020
Lead, Total	12200	1200	mg/kg dry	11/13/03	DSC	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/29/03 @ 10:20
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B26-3- 10
Sample #: 348108
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	114	25	mg/kg dry	11/13/03	DSC	USEPA-6020
Lead, Total	6020	600	mg/kg dry	11/13/03	DSC	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/29/03 @ 10:30
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B27-0-3
Sample #: 348109
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	25	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	786	120	mg/kg dry	11/13/03	DSC	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client: Advanced GeoServices Corporation
Project: RMC - Beech Grove, IN

Sampled: 10/29/03 @ 10:40
Sampler:
Received: 10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B27-3- 10
Sample #: 348110
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	35	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	658	120	mg/kg dry	11/13/03	DSC	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client: Advanced GeoServices Corporation
Project: RMC - Beech Grove, IN

Sampled: 10/29/03 @ 11:00
Sampler:
Received: 10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B28-0-3
Sample #: 348111
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	23	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	684	120	mg/kg dry	11/13/03	DSC	USEPA-6020

JMD 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/29/03 @ 11:05
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B28-3- 10
Sample #: 348112
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	20	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	403	60	mg/kg dry	11/13/03	DSC	USEPA-6020

JMB 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

ANALYTICAL REPORT

Client: Advanced GeoServices Corporation
Project: RMC - Beech Grove, IN

Sampled: 10/29/03 @ 11:10
Sampler:
Received: 10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B28D-3-10
Sample #: 348113
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	22	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	490	60	mg/kg dry	11/13/03	DSC	USEPA-6020

JMB 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix
Laboratories, Inc.

ANALYTICAL REPORT

Client: Advanced GeoServices Corporation
Project: RMC - Beech Grove, IN

Sampled: 10/29/03 @ 11:30
Sampler:
Received: 10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: EB-4-102903
Sample #: 348114
Matrix: QC Water

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	<1.0	1.0	ug/L	11/12/03	MSG	EPA-200.8/6020
Lead, Total	<1.0	1.0	ug/L	11/12/03	MSG	EPA-200.8/6020

End of Analytical Report

JMB 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

Blank Contamination

Blank ID	Batch No.	Analyte	Conc. (mg/kg)	Conc * 5	Associated Samples	Sample Conc. (mg/kg)
MPB	90840-105	Lead	0.64	3.2	R25B27-3-10	658
					R25B28-0-3	684
					R25B28-3-10	403
					R25B28D-3-10	490

MB 1/9/2004

TriMatrix
Laboratories, Inc.

QUALITY CONTROL REPORT
BLANKS
USEPA CLP FORM 3

SDG No. 35132 -35 Parameter Lead, Total
Instrument ID 201

Batch Number	Blank Type		Amount Found	Quant. Limit	Reference Citation	Matrix	Units
209224	BLK	1	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209224	ICB	1	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209224	CCB	1	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209224	CCB	2	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209224	CCB	3	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209224	CCB	4	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209246	BLK	1	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209246	ICB	1	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209246	CCB	1	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209246	CCB	2	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209246	CCB	3	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209246	CCB	4	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209246	CCB	5	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209303	BLK	1	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209303	ICB	1	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209303	CCB	1	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209303	CCB	2	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209303	CCB	3	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209303	CCB	4	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
90838-105	MPB	1	<0.60	0.60	USEPA-6020	SOIL	mg/kg dry
90840-105	MPB	1	0.64	0.60	USEPA-6020	SOIL	mg/kg dry
90843-104	MPB	1	<1.0	1.0	EPA-200.8/6020	WATER	ug/L

Associated Samples

R25B27-3-10
R25B28-0-3
R25B28-3-10
R25B28D-3-10

JMB 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

Site Name: RMC Beech Grove

Project Number: 2003-1046-03

Laboratory: Trimatrix

Field Duplicates

Sample ID	Analyte	Units	Result	RPD	Qualifier
R2SED-12-0-6	Arsenic	mg/kg	11		
R2SED-12D-0-6		mg/kg	12	8.70	
	Lead	mg/kg	411		
		mg/kg	462	11.68	
R25B28-3-10	Arsenic	mg/kg	20		
R25B28D-3-10		mg/kg	22	9.52	
	Lead	mg/kg	403		
		mg/kg	490	19.48	

Duplicate Criteria: Soil/Solid matrices <40 %RPD for samples with results > EQL

* - Denotes %RPD outside criteria.

NA - Duplicate relative percent difference cannot be calculated.

ND - Not detected.

JMD 1/9/2004

ATTACHMENT 2

Baseline Human Health Risk Assessment for

Refined Metals Corporation Facility

Beech Grove, Indiana

Conducted as Part of the

Phase I Corrective Measures Study

Prepared for
Refined Metals Corporation
3000 Montrose Ave.
Reading, PA 19605-2751

Prepared by
Gradient Corporation
20 University Road
Cambridge, MA 02138

May 5, 2005

Table of Contents

Page

1 Introduction

1.1 Site Description and History

The Refined Metals Corporation (RMC) facility is located at 3700 South Arlington Avenue in Beech Grove, Indiana. Secondary lead smelting and refining operations were conducted at this site from 1968 to the end of 1995.

The site occupies approximately 24 acres, of which approximately 10 acres represented the active manufacturing area (including paved areas and buildings). The remaining 14 acres includes grassed and wooded site areas. The site is bordered by Arlington Avenue to the east, a natural gas facility (Citizen's Gas) to the west, a railroad to the north, and Big Four Road to the south (Figure 1). The site is relatively flat with less than 10 feet of total relief. Natural site drainage is toward the north and east. The former manufacturing area is almost completely paved, and is characterized by nearly 80,000 square feet of structures consisting of the battery breaker, a wastewater treatment plant, material storage areas, a blast furnace, a dust furnace, a metals refining area, warehouse and offices.

A total of five exposure areas were evaluated (Figure 1). One onsite area was the fenced main plant area of the RMC facility, consisting of the plant buildings and surrounding paved areas. The second onsite area was the grassy area to the north, east, and south of the paved facility area. Within the grassy area, the two ditches where sediments were collected (Figure 1) were evaluated separately for certain receptors. Three areas were evaluated offsite: a strip along Arlington Avenue, just outside the eastern border of the RMC facility; the Railroad Ditch along the northern border of the RMC facility, and the Citizen's Gas property to the west of the RMC facility.

1.2 Previous Investigations

On July 14, 1998, RMC entered into a Consent Decree with the United States Environmental Protection Agency (USEPA) and the Indiana Department of Environmental Management (IDEM). Under this Consent Decree, a RCRA Facility Investigation (RFI) was performed to evaluate and determine the nature and extent of releases and to collect information necessary to support risk assessment so that a Corrective Measures Study may be implemented. Pursuant to Section VI, Paragraph 42 of the Consent Decree (Compliance Requirements for Corrective Action), Advanced GeoServices Corp. (AGC) performed the RFI in accordance with an approved RFI work plan on behalf of RMC. The preparation and implementation of the RFI work plans were enacted in accordance with Exhibit B of the Consent Decree and the EPA's RCRA Facility Investigation Guidance Document (EPA 530/SW-89-031). The RFI was conducted in multiple phases. The results from the initial phase of sampling were presented in the Phase I RFI Report dated August 31, 2000 (AGC, 2000). Based on the results of the Phase I RFI a Phase II RFI Work Plan was submitted to the EPA on December 20, 2000. In response to comments on the Phase II RFI Work Plan issued by the EPA on April 3, 2001, revisions to the Phase II RFI Work Plan were submitted to the EPA on June 27, 2001. The EPA approved the Phase II RFI Work Plan on July 13, 2001, the results of which were contained in the Final Phase II RFI Report dated February 4, 2003. (AGC, 2003). Additional site sampling was conducted during a closure investigation to address three former RCRA-regulated solid waste managements units (SWMUs). The results of the SWMU closure investigation were presented by AGC in the Closure Investigation Report dated June 1, 2001.

1.3 Report Objectives and Organization

This report presents the results of the baseline human health risk assessment (HHRA) that was conducted to evaluate potential human health risks in each exposure area. The purpose of this evaluation is to determine whether these areas pose any unacceptable health risks or if they require remediation to reduce risk to acceptable levels.

The remainder of this report is organized in the following sections. Section 2 discusses the data used in the risk assessment, and the constituents of potential concern. Section 3 discusses the potential receptors, exposure media, and exposure pathways for each exposure area. Section 4 presents the toxicity assessment. Section 5 presents the risk characterization. Section 6 presents soil lead cleanup levels. Section 7 presents the conclusions for all scenarios evaluated.

2 Constituents of Potential Concern

The results of the Phase I RFI indicated that lead and arsenic are the main contaminants of concern in soil, both onsite and offsite. Lead and arsenic were detected in soil samples from the site at concentrations above both residential and industrial risk-based concentrations (RBCs). The baseline risk assessment retained lead and arsenic as chemicals of potential concern (COPCs) in soil.

3 Exposure Assessment

3.1 Potential Receptors and Exposure Pathways

The potential receptors, exposure media, exposure pathways, and exposure frequencies evaluated in each exposure area are presented in Table 1, and are discussed in more detail below. Exposure Areas are shown in Figure 1.

Table 1
Receptors and Exposure Pathways

Exposure Area	Media	Depth	Exposure Pathways	Receptors	Exposure Frequency (days/year)	Exposure Duration (years)
Plant Area	Subsurface soil	0-5 ft	Ingestion, Dermal Contact	Construction Worker 1	50	5
				Construction Worker 2	250	1
				Utility Worker	10	10
Grassy Area	Soil and Sediment	0-6"	Ingestion, Dermal Contact	Groundskeeper	50	25
				Future Site Worker	144	25
	Soil and Sediment	0-5 ft	Ingestion, Dermal Contact	Construction Worker 1	50	5
				Construction Worker 2	250	1
	Sediment	0-6"	Ingestion, Dermal Contact	Adolescent Trespasser	21	5
	Soil	0-6"		Adolescent Trespasser	21	5
Arlington Avenue	Sediment	0-3"	Ingestion, Dermal Contact	Adolescent Recreator	42	5
Railroad Ditch	Sediment	0-3"	Ingestion, Dermal Contact	Adolescent Recreator	42	5
Off Site Natural Gas Facility	Surface soil	0-6"	Ingestion, Dermal Contact	Adult Worker	225	25

3.1.1 Facility Area

The plant buildings and surrounding paved areas occupy approximately the central third of the RMC property. The site is largely paved – the only exposed surface soil is limited to a strip along the western fence line. In this exposure area, we evaluated a utility worker and two types of construction workers who could be exposed to subsurface soil. Both the utility and construction workers are assumed to be exposed to subsurface soil at depths from 0 to 5 feet, *via* incidental ingestion and dermal contact. The utility worker is assumed to have an exposure frequency of 10 days/year and an exposure duration of 10 years. Construction Worker 1 is assumed to have an exposure frequency of 50 days/year for 5 years; this scenario assumes that Exide retains the property, and represents a worker assigned to several small projects per year over a 5 year period. Construction Worker 2 is assumed to have an exposure frequency of 250 days/year for 1 year; this scenario assumes that Exide sells the property, and the property undergoes one year of redevelopment involving subsurface excavation.

3.1.2 Grassy Area North, South, and East of Main Facility

The grassy and wooded areas located north, south, and east of the main facility encompass approximately the northern and southern thirds of the RMC property (Figure 1). The receptors evaluated in both of these areas include an adolescent trespasser and an adult groundskeeper under current use, a future site worker, and two types of construction workers who could be exposed to subsurface soil. A future site worker might be present in the grassy area if the property were sold and the grassy area was not redeveloped. These receptors are assumed to be exposed to soil and/or sediment *via* incidental ingestion and dermal contact. The adolescent trespasser (age 13-18 years) is assumed to have an exposure frequency of 21 days/year and an exposure duration of 5 years. The groundskeeper is assumed to have an exposure frequency of 50 days/year and an exposure duration of 25 years. A future site worker is assumed to spend most of his time in the plant and surrounding paved areas. However, he may have occasion to visit the grassy/wooded areas for a walk or to eat lunch at a picnic table. The future site worker is assumed to have an exposure frequency in these areas of 4 days/week for 36 weeks/year or 144 days/year, and an exposure duration of 25 years. Construction Worker 1 is assumed to have an exposure frequency of 50 days/year for 5 years; this scenario assumes that Exide retains the property, and represents a worker assigned to several small projects per year over a 5 year period. Construction Worker 2 is assumed to have an exposure frequency of 250 days/year for 1 year; this scenario assumes that Exide sells the property, and the property undergoes one year of redevelopment involving subsurface excavation.

3.1.3 Offsite Natural Gas Facility

At the offsite natural gas facility, an adult commercial worker was evaluated. The worker is assumed to be exposed to surface soil *via* incidental ingestion and dermal contact. The worker is assumed to have an exposure frequency in these areas of 5 days/week for 45 weeks/year, or 225 days/year, and an exposure duration of 25 years.

3.1.4 Arlington Avenue

In the strip along Arlington Avenue outside the eastern border of the facility, an adolescent recreator was evaluated. The recreator is assumed to be exposed to sediment *via* incidental ingestion and dermal contact for 42 days/year. The adolescent recreator is 13-18 years old, therefore his exposure duration is 5 years.

3.1.5 Railroad Ditch

In the Railroad Ditch area along the northern border of the RMC facility, an adolescent recreator was evaluated. The recreator is assumed to be exposed to sediment *via* incidental ingestion and dermal contact for 42 days/year. The adolescent recreator is 13-18 years old, therefore his exposure duration is 5 years.

3.2 Exposure Point Concentrations

In a risk assessment, an Exposure Point Concentration (EPC) represents the concentration of a chemical in an environmental medium to which an individual is exposed. The calculation of EPCs is described below. The EPCs used in this risk evaluation are presented in Table 2. The datasets used and the EPC calculations are presented in Appendix B for lead and Appendix C for arsenic.

Table 2
Exposure Point Concentrations

Exposure Area	Receptor	Media	Depth	Arsenic 95%UCL mg/kg	Arsenic 95%UCL Basis	Lead Mean mg/kg
Onsite	Construction Worker 1 & 2, Utility Worker	Soil	0-5 ft	123	NP, Bootstrap	20,266
Grassy Area	Groundskeeper, Future Site Worker	Soil and Sediment	0-6 in	779	NP, Chebyshev 99% UCL	20,158
	Construction Worker 1 & 2	Soil and Sediment	0-30 in	818	NP, Chebyshev 99% UCL	13,392
	Adolescent Trespasser	Soil	0-6 in	60	NP, Chebyshev 95% UCL	1,908
	Adolescent Trespasser	Sediment	0-6 in	1,387	Gamma UCL	89,100
Arlington Ave	Adolescent Recreator	Sediment	0-3 in	38	NP, Chebyshev 95% UCL	3,032
Railroad Ditch	Adolescent Recreator	Sediment	0-3 in	169	Max	5,150
Offsite Gas Facility	Worker	Soil	0-6 in	28.5	LN, H-UCL	1,311

NP Nonparametric
LN Lognormal

For arsenic, the EPCs were the 95% upper confidence level on the mean (95UCL) concentration. The 95UCL is used instead of the mean or arithmetic average because it is not possible to know the true mean (USEPA, 1992b). The 95UCL is defined as a value that …"equals or exceeds the true mean 95% of the time" (USEPA, 1992b). As sampling data become more representative of actual site conditions, uncertainties decrease, and the 95UCL approaches the true mean. The 95UCL values were calculated with ProUCL© according to USEPA guidance (USEPA, 2002a).

To evaluate lead risks, the arithmetic mean soil lead concentration within the exposure area was used as the EPC to be consistent with USEPA guidance (USEPA, 1994; USEPA, 1996)

3.3 Quantification of Exposure

This section discusses the basis for calculating human intake levels resulting from exposures to COPCs other than lead (in this case arsenic), and describes each input parameter. Human intake levels for lead are discussed in Section 5. Exposure estimates represent the daily dose of a chemical taken into the body, averaged over the appropriate exposure period, expressed in the units of milligram (mg) of chemical per kilogram (kg) of human body weight per day. The primary source for the exposure equations used in the HHRA is the USEPA's "*Risk Assessment Guidance for Superfund* (RAGS)" (USEPA, 1989).[1] The generalized equation for calculating chemical intakes is shown below:

$$I = \frac{EPC \times CR \times EF \times ED}{BW \times AT}$$

where:

I	=	Intake, the amount of chemical at the exchange boundary (mg/kg body weight-day),
EPC	=	Exposure Point Concentration, the chemical concentration contacted over the exposure period at the exposure point (*e.g.*, mg/kg in soil),
CR	=	Contact Rate, the amount of contaminated medium contacted per unit time or event (*e.g.*, soil ingestion rate (mg/day)),
EF	=	Exposure Frequency, describes how often exposure occurs (days/year),
ED	=	Exposure Duration, describes how long exposure occurs (yr),
BW	=	Body Weight, the average body weight over the exposure period (kg), and
AT	=	Averaging Time, period over which exposure is averaged (days).

Exposure factors (*e.g.*, contact rate, exposure frequency, exposure duration, body weight) describe a receptor's exposure for a given exposure scenario. The values used for each exposure factor are summarized in Table 3 and discussed in detail below. The exposure factor input values are consistent with current USEPA guidance. Where appropriate, exposure parameters were based on site-specific considerations and professional judgment.

[1] Note that this approach is not used to evaluate lead. Consistent with USEPA guidance, lead exposure is evaluated using a child or adult lead model to estimate blood lead levels.

Table 3
Summary of Exposure Factor Input Values for Arsenic Risks

Exposure Area Medium Receptor	Onsite Soil Construction Worker 1	Onsite Soil Construction Worker 2	Onsite Soil Utility Worker	Grassy Area Soil/Sediment Grounds-keeper	Grassy Area Soil/Sediment Future Site Worker	Grassy Area Soil/Sediment Construction Worker 1
Exposure Pathway/Exposure Factor						
Ingestion of Soil						
Ingestion Rate (mg/day)	330	330	330	100	50	330
Exposure Duration (yr)	5	1	10	25	25	5
Exposure Frequency (days/yr)	50	250	10	50	144	50
Body Weight (kg)	70	70	70	70	70	70
Bioavailability (arsenic)	0.8	0.8	0.8	0.8	0.8	0.8
Conversion Factor (kg/mg)	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001
Fraction from Contaminated Source	1	1	1	1	1	1
Averaging Time (days) – Cancer	25550	25550	25550	25550	25550	25550
Averaging Time (days) - Non Cancer	1825	365	3650	9125	9125	1825
Dermal Contact with Soil						
Dermal Absorption Factor (arsenic)	0.03	0.03	0.03	0.03	0.03	0.03
Soil Adherence Factor (mg/cm^2)	0.2	0.2	0.2	0.2	0.07	0.2
Surface Area (cm^2/d)	3300	3300	3300	3300	3300	3300
Exposure Duration (years)	5	1	10	25	25	5
Exposure Frequency (days/yr)	50	250	10	50	144	50
Body Weight (kg)	70	70	70	70	70	70
Conversion Factor (kg/mg)	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001
Fraction from Contaminated Source	1	1	1	1	1	1
Averaging Time (days) - Cancer	25550	25550	25550	25550	25550	25550
Averaging Time (days) - Non Cancer	1825	365	3650	9125	9125	1825

Table 3
Summary of Exposure Factor Input Values for Arsenic Risks (cont'd)

Exposure Area Medium Receptor	Grassy Area Soil/Sediment Construction Worker 2	Grassy Area Soil Adolescent Trespasser	Grassy Area Sediment Adolescent Trespasser	Arlington Ave. Sediment Adolescent Recreator	Railroad Ditch Sediment Adolescent Recreator	Offsite Gas Facility Soil Worker
Exposure Pathway/Exposure Factor						
Ingestion of Soil						
Ingestion Rate (mg/day)	330	50	50	50	50	50
Exposure Duration (yr)	1	5	5	5	5	25
Exposure Frequency (days/yr)	250	21	21	42	42	225
Body Weight (kg)	70	58	58	58	58	70
Bioavailability (arsenic)	0.8	0.8	0.8	0.8	0.8	0.8
Conversion Factor (kg/mg)	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001
Fraction from Contaminated Source	1	1	1	1	1	1
Averaging Time (days) – Cancer	25550	25550	25550	25550	25550	25550
Averaging Time (days) - Non Cancer	365	1825	1825	1825	1825	9125
Dermal Contact with Soil						
Dermal Absorption Factor (arsenic)	0.03	0.03	0.03	0.03	0.03	0.03
Soil Adherence Factor (mg/cm^2)	0.2	0.07	0.07	0.07	0.07	0.2
Surface Area (cm^2/d)	3300	4270	4270	4270	4270	3300
Exposure Duration (years)	1	5	5	5	5	25
Exposure Frequency (days/yr)	250	21	21	42	42	225
Body Weight (kg)	70	58	58	58	58	70
Conversion Factor (kg/mg)	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001
Fraction from Contaminated Source	1	1	1	1	1	1
Averaging Time (days) - Cancer	25550	25550	25550	25550	25550	25550
Averaging Time (days) - Non Cancer	365	1825	1825	1825	1825	9125

3.3.1 Ingestion of Soil

For the soil ingestion pathway intake is calculated as:

$$Intake\left(\frac{mg}{kg \cdot day}\right) = \frac{C_{soil}\left(\frac{mg}{kg}\right) \times B \times IR_{soil}\left(\frac{mg}{day}\right) \times FS \times EF\left(\frac{days}{yr}\right) \times ED(yrs) \times 10^{-6}\,\frac{kg}{mg}}{BW(kg) \times AT(days)}$$

where:

C_{soil}	=	Concentration of the chemical in soil (mg/kg)
B	=	Relative Bioavailability, the relative oral absorption fraction (unitless)
IR_{soil}	=	Soil Ingestion Rate (mg/day)
FS	=	Fraction of Soil from the site (unitless)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)

Gradient used conservative USEPA-recommended values for each of the input parameters. The basis for each value used is detailed below.

Soil Concentrations (C_{soil}). As summarized in Section 3.2, the 95UCL was used as the EPC.

Relative Bioavailability (B). To accurately quantify potential exposures from ingestion of soil, it is important to consider the amount of a chemical that is solubilized in gastrointestinal fluids and absorbed across the gastrointestinal tract into the bloodstream. A chemical present in soil may be absorbed less completely than the same dose of the chemical administered in toxicity studies used to evaluate safe dose levels. A relative bioavailability estimate for a specific compound represents the absorption fraction from soil (the exposure route of concern) relative to the absorption fraction from food or water (in most toxicity studies, chemical doses are administered in food or water).

It is widely recognized that bioavailability of many metals and organics from soil tends to be considerably lower than bioavailability from food or water. USEPA guidance recognizes the need to make adjustments for the reduced bioavailability of compounds in soil. Specifically, in Appendix A of USEPA's Risk Assessment Guidance for Superfund (USEPA, 1989, pg. A-3), USEPA notes:

> If the medium of exposure in the site exposure assessment differs from the medium of exposure assumed by the toxicity value (*e.g.*, RfD values usually are based on or have been adjusted to reflect exposure *via* drinking water, while the site medium of concern may be soil), an absorption adjustment may, on occasion, be appropriate. For example, a substance might be more completely absorbed following exposure to contaminated drinking water than following exposure to contaminated food or soil (*e.g.*, if the substance does not desorb from soil in the gastrointestinal tract).

USEPA Region 10 risk assessment guidance provides default values for the bioavailability of arsenic in soil. Region 10 notes that if the site is a smelter site and its appears likely that the arsenic exists primarily as finely-grained oxides from smelter stack emissions, then a value of 80% relative bioavailability may be assumed. Region 10 notes that this value is supported by a conservative interpretation of the scientific literature (USEPA Region 10, 1997). A relative bioavailability of 80% was used for arsenic in this risk assessment.

For lead, the USEPA recommends an oral absorption factor for adults of 0.12 for ingestion of lead in soil, based on 20% absorption of soluble lead, and a relative bioavailability of 60% for lead in soil (*i.e.*, $0.12 = 0.2 \times 0.6$) (USEPA, 1996). Gradient used the recommended USEPA absorption factor of 0.12 to evaluate ingestion of lead contaminated soil for adult receptors.

Soil Ingestion Rate (IR_{soil}). A daily soil and dust ingestion rate of 50 mg/day was used for the adolescent trespasser, adolescent recreator, site worker, and offsite gas facility worker. USEPA considers this value to be a reasonable central estimate of adult soil ingestion and notes that although this value is highly uncertain, "a recommendation for an upper percentile value would be inappropriate" (USEPA, 1997a). A daily soil and dust ingestion rate of 100 mg/day was used for the groundskeeper (USEPA, 2002b). A daily soil and dust ingestion rate of 330 mg/day was used for the onsite construction worker and the onsite utility worker, as these receptors are assumed to have more intensive contact with soil than the other adult receptors (USEPA, 2002b).

Fraction of Soil From the Site (FS). For all receptors, it was assumed that 100% of the individual's daily soil exposure occurred at the site. This assumption is likely to overestimate exposure to contaminated soil for workers, trespassers, and recreators because workers are assumed to be at the site for only 8 hours per day, and trespassers are likely present less than 2 hours per visit.

Exposure Frequency (EF) and Exposure Duration (ED). The exposure frequency and duration used for each receptor are discussed in Section 3.1.1 to 3.1.3. For the site worker, groundskeeper, and offsite gas worker, the exposure duration is 25 years. This is the 95th percentile duration that an individual stays at any one workplace (USEPA, 1991). Hence, this assumption overestimates exposures for most workers, because the median occupational tenure of the working population has been estimated to be 6.6 years (USEPA, 1997a).

Body Weight (BW). Although the average U.S. adult body weight in the current Exposure Factors Handbook (USEPA, 1997a) is 71.8 kg, a mean adult body weight of 70 kg (USEPA, 1991) was used in the HHRA, so that the body weight would be consistent with that used in deriving the toxicity factors. Average body weight for the adolescent trespasser and recreator (13-18 year old) was calculated from data in USEPA's Exposure Factors Handbook and used in the HHRA (USEPA, 1997a).

Averaging Time (AT). For non-cancer risks, the averaging time was equal to the exposure duration multiplied by 365 days/year. For cancer risks, exposures were averaged over a 70-year average lifetime (USEPA, 1991). Although the current life expectancy for men and women in the U.S. is 76.7 years (USEPA, 1997a), a value of 70 years (25,550 days) was used to be consistent with the value used in deriving the toxicity factors.

3.3.2 Dermal Contact with Surface Soil

For dermal exposure to contaminants in soil, a dermal intake (the amount absorbed into the body) is calculated as (USEPA, 2004c):

$$Intake\left(\frac{mg}{kg \cdot day}\right) = \frac{C_{soil}\left(\frac{mg}{kg}\right) \times DA \times AF\left(\frac{mg}{cm^2}\right) \times SA\left(\frac{cm^2}{event}\right) \times EF\left(\frac{events}{yr}\right) \times ED(yrs) \times 10^{-6}\,\frac{kg}{mg}}{BW(kg) \times AT(days)}$$

where:

C_{soil}	=	Concentration of the chemical in soil (mg/kg),
DA	=	Dermal Absorption factor (unitless)
AF	=	Soil/skin Adherence Factor (mg/cm^2),
SA	=	Skin surface Area exposed (cm^2/exposure event),
EF	=	Exposure Frequency (exposure events/year),
ED	=	Exposure Duration (years),
BW	=	Body Weight (kg), and
AT	=	Averaging Time (days).

There are three parameters in this equation that are different from those discussed in the previous section (Section 3.3.1). Only those parameters unique to the dermal exposure equation, dermal absorption fraction (DA), the soil adherence factor (AF), and the skin surface area (SA), are discussed in this section.

Note that since absorbed doses are used for the dermal pathway, the toxicity criteria are adjusted so they apply to absorbed doses. This adjustment is discussed in more detail in the toxicity section (Section 4).

Dermal Absorption Fraction (DA). The dermal absorption fraction represents the amount of a chemical in contact with skin that is absorbed through the skin and into the bloodstream. The dermal absorption fraction for arsenic (0.03) was obtained from USEPA's dermal risk assessment guidance (USEPA, 2004c; Table 3.4).

Soil to Skin Adherence Factor (AF). The adherence factor relates the amount of soil that adheres to the skin per unit of surface area (USEPA, 2004c). Adherence factors vary depending on the properties of the soil, the part of the body, and the type of activity. Gradient used the 50^{th} percentile weighted adherence factors from USEPA's dermal risk assessment guidance (USEPA, 2004c). The AF for utility workers (0.2 mg/cm^2) was used for the construction worker, utility worker, groundskeeper, and offsite gas facility worker. EPA's recommended AF for the residential adult (0.07 mg/cm^2) was used for the future site worker, adolescent trespasser, and adolescent recreator.

Skin Surface Area Exposed (SA). This parameter reflects the amount of skin that is available for exposure to soil. The skin surface areas used in the HHRA were 3300 cm^2 for the construction worker, utility worker, site worker, groundskeeper, and offsite gas facility worker, based on the face, hands, and forearms; and 4270 cm^2 for the trespasser and recreator, based on the face, hands, forearms, and lower legs. Surface areas were calculated using USEPA's Exposure Factors Handbook (USEPA, 1997a).

4 Toxicity Assessment

4.1 Overview of Toxicity Values

Gradient has evaluated potential cancer and non-cancer risks from exposure to arsenic using dose-response relationships for carcinogenicity (oral Cancer Slope Factors) and systemic toxicity (oral Reference Doses). Lead toxicity is discussed separately in Section 4.2. The primary source of toxicity values was the USEPA's Integrated Risk Information System (IRIS) (USEPA, 2004a). Toxicity values in IRIS undergo a rigorous peer review process and are generally considered to be of high quality. The toxicity factors used in the HHRA are summarized in Table 4.

Table 4
Toxicity Factors

Compound	RfD_{oral} (mg/kg-day)	Critical Effect	RfD Source	Uncertainty Factor	Oral Absorption	RfD_{dermal} (mg/kg-day)	CSF_{oral} (mg/kg-day)	CSF_{dermal} (mg/kg-day)
Arsenic	0.0003	Hyperpigmentation, keratosis and possible vascular complications	IRIS	3	95%	0.0003	1.5	1.5

4.1.1 Oral Reference Doses (RfD_{oral})

An RfD is an estimate of daily exposure that a sensitive population can experience over a lifetime with a negligible risk of systemic health effects. The USEPA derives RfDs by first identifying the highest dose level that does not cause observable adverse effects (*i.e.*, the No Observed-Adverse Effect Level, or NOAEL; USEPA, 1993). If a NOAEL was not identified, a Lowest Observed Adverse Effect-Level, or LOAEL, may be used. This dose level is then divided by uncertainty factors to calculate an RfD. An uncertainty factor of 100 is often used, to account for interspecies differences (if animal studies were used) and sensitive human subpopulations (*e.g.*, children and the elderly; USEPA, 1993). Additional uncertainty factors may be used, depending on the quality of the toxicological data.

4.1.2 Oral Cancer Slope Factors (CSF_{oral})

The CSF is an upper bound estimate of carcinogenic potency used to calculate risk from exposure to carcinogens, by relating estimates of lifetime average chemical intake to the incremental risk of an individual developing cancer over their lifetime (USEPA, 1992c). The CSFs recommended by the

USEPA are conservative upper bound estimates, which means that the USEPA is reasonably confident that the "true" cancer risk does not exceed the estimated risk calculated using the CSF, and may be as low as zero.

4.1.3 Dermal Reference Doses (RfD_{dermal})

There are no USEPA-derived toxicity values based specifically on toxicity studies involving dermal exposures. In the absence of dermal-specific RfDs, oral toxicity factors are used, assuming that once a chemical is absorbed into the blood stream, the health effects are similar regardless of whether the route of exposure is oral or dermal. However, since oral toxicity criteria are based on the amount of a chemical *administered* per unit time and body weight (chemical intake), they need to be adjusted to be applicable to *absorbed* doses (dermal exposures are expressed as absorbed intake levels) (USEPA, 1989; 1992a; 2004c).

Since most RfDs are based on studies where a chemical is administered in food or water, this adjustment is made using the oral absorption efficiency for that chemical. If oral absorption is very high (almost 100%), then the absorbed dose is virtually the same as the administered dose, and no adjustment of the toxicity factor is necessary. If oral absorption is very low (*e.g.*, 5%), the absorbed dose is much smaller than the administered dose, and an adjustment of the toxicity criteria is necessary. For any given chemical, the USEPA recommends adjusting the oral toxicity factor for use in evaluating dermal risks only when the oral absorption for that chemical is less than 50%, to "obviate the need to make comparatively small adjustments in the toxicity value that would otherwise impart on the process a level of accuracy that is not supported by the scientific literature" (USEPA, 2004c).

For non-cancer effects, this adjustment is made by multiplying the oral RfD (for applied doses) by the oral absorption efficiency (*i.e.*, $RfD_{oral} \times Abs_{oral} = RfD_{dermal}$). For arsenic, the oral absorption efficiency is 95%, therefore no adjustment is necessary and the RfD_{dermal} is the same as the RfD_{oral} (Table 4).

4.1.4 Dermal Cancer Slope Factors (CSF_{dermal})

There are no USEPA-derived toxicity values specifically for cancer studies involving dermal exposures. In the absence of dermal-specific CSFs, oral CSFs are used, assuming that once a chemical is absorbed into the blood stream, the carcinogenic effect is similar regardless of whether the route of exposure is oral or dermal. However, since oral CSFs are based on the amount of a chemical *administered* per unit time and body weight (chemical intake), they need to be adjusted to be applicable to *absorbed* doses (dermal exposures are expressed as absorbed intake levels) (USEPA, 1989; 1992a; 2004c). For any given chemical, the USEPA recommends adjusting the oral CSF for use in evaluating dermal risks only when the oral absorption for that chemical is less than 50%, to "obviate the need to make comparatively small adjustments in the toxicity value that would otherwise impart on the process a level of accuracy that is not supported by the scientific literature" (USEPA, 2004c).

For cancer, this adjustment is made by dividing the oral CSF (for applied doses) by the oral absorption efficiency (*i.e.*, $CSF_{oral} / Abs_{oral} = CSF_{dermal}$), if the oral absorption efficiency is less than 50%. For arsenic, this value is 95%, therefore the CSF_{dermal} is the same as the CSF_{oral} (Table 4).

4.2 Toxicity Values for COPCs

The basis of the arsenic toxicity values is described in this section and summarized in Table 4. Lead toxicity is also discussed in this section because of the unique way exposure and risk are evaluated for this metal.

4.2.1 Arsenic

The toxicity criteria for arsenic were obtained from the USEPA IRIS database (USEPA, 2004a). The derivation of each of these values, and the scientific uncertainties concerning arsenic toxicity, are discussed below.

4.2.1.1 Arsenic RfD_{oral}

USEPA cites an RfD_{oral} for arsenic of 0.0003 mg/kg-day (USEPA, 2004a). The arsenic RfD_{oral} is based on increased incidence of hyperpigmentation, keratosis and possible vascular complications in a study of a large population (over 40,000 people) in Taiwan with chronic exposure to arsenic in drinking water and food (Tseng, 1977; Tseng *et al.*, 1968). The USEPA characterized a NOAEL of 0.0008 mg/kg/day for skin lesions in the Tseng study, based on the drinking water concentration in the NOAEL group (0.009 mg/L), an assumed drinking water ingestion rate of 4.5 L, daily arsenic intake from sweet potatoes and rice of 0.002 mg/day, and an average Taiwanese body weight of 55 kg ((0.009 mg/L × 4.5 L/day) + 0.002 mg/day / 55 kg) (Abernathy *et al.*, 1989). An uncertainty factor of 3 (based on the lack of reproductive toxicity data and uncertainty regarding toxicity in sensitive individuals) was applied to the NOAEL to derive an RfD of 0.0003 mg/kg/day (0.0008/3). Overall, the USEPA has "medium" confidence in the study, "medium" confidence in the database (due to poor characterization of the dose levels in the Tseng and other supporting studies), and "medium" confidence in the RfD_{oral} for arsenic. It is noted in the arsenic IRIS file that a clear consensus does not exist among USEPA scientists regarding arsenic systemic toxicity (USEPA, 2004a).

4.2.1.2 Arsenic CSF_{oral}

USEPA concluded that arsenic is a "human carcinogen," a weight-of-evidence classification for carcinogenicity of "A" (USEPA, 2004a). This classification is based on sufficient evidence of carcinogenicity in human populations. Lung cancer has been associated with inhalation of arsenic, and skin, bladder, and possibly other internal cancers have been associated with ingestion of arsenic in drinking water.

In IRIS, the USEPA recommends a CSF_{oral} value for arsenic of 1.5 $(mg/kg/day)^{-1}$ (USEPA, 2004a). This value is based on skin cancer incidence rates in the same Taiwanese study used as the basis for the RfD_{oral} value (Tseng, 1977; Tseng *et al.*, 1968). This value was calculated using a multistage model, assuming a drinking water ingestion rate of 3.5 L/day for Taiwanese males and 2 L/day for Taiwanese females, an average Taiwanese body weight of 55 kg, and an average U.S. body weight of 70 kg.

There is currently considerable debate among the scientific community regarding the arsenic CSF_{oral}. Many researchers believe that the current value of 1.5 $(mg/kg/day)^{-1}$ may overestimate cancer risks for U.S. populations (see, for example, Slayton *et al.*, 1996; Chappell *et al.*, 1997).

4.2.1.3 Arsenic RfD_{derm} and CSF_{derm}

In general, for dermal exposures (expressed as absorbed intake levels), the RfD_{oral} and CSF_{oral} are adjusted to be applicable to absorbed doses (USEPA, 1989; 1992a). This adjustment is made assuming that once a chemical is absorbed into the blood stream, the health effects are similar regardless of whether the route of exposure is oral or dermal. However, since oral absorption for arsenic is about 95% (USEPA, 2004c), and the USEPA recommends adjusting dermal toxicity factors only when oral absorption is less than 50%, no adjustment was made for arsenic.

4.2.2 Lead

The ingestion of lead at certain levels can result in significant health effects, particularly among children. Epidemiological investigators have reported a correlation between blood lead levels (BLLs) in children and adverse health effects. High levels of lead intake can cause kidney damage, convulsions, coma, and even death (ATSDR, 1999). However, health effects resulting from lower levels of lead exposure are more common, and are related to cognitive and neuro-behavior impacts, including the impairment of intellectual performance.

The USEPA has not established any toxicity criteria (RfD, CSF) for lead (USEPA, 2004b); instead, lead risks are evaluated by modeling blood lead levels. Lead risks in adults were evaluated using USEPA's Adult Lead Model (USEPA, 2003). This model is discussed in more detail in Section 5.4.

The USEPA has assigned lead a Weight-of-Evidence Classification for human carcinogenicity of "B2", a "probable human carcinogen," based on sufficient animal evidence but inadequate human evidence (USEPA, 2004b). Even though the weight of evidence for lead carcinogenicity is B2, the USEPA does not evaluate lead cancer risk using a CSF, having concluded that neurological effects in young children are the most relevant endpoint.

5 Risk Characterization

In this section, cancer and non-cancer health risks are estimated by combining the information from Sections 2 through 4. The calculations used to estimate cancer and noncancer risks are presented in Sections 5.1 and 5.2, respectively. Section 5.3 discusses the calculated cancer and noncancer risks for each exposure area. Section 5.4 presents the lead risks by exposure area. Section 5.5 provides a qualitative discussion of the most significant sources of uncertainty in the risk estimates.

5.1 Calculation of Cancer Risks

Excess lifetime cancer risks are characterized as the incremental probability that an individual will develop cancer during his or her lifetime due to chemical exposure to constituents at the site under the specific exposure scenarios evaluated. The term "incremental" implies the risk above the background cancer risk experienced by all individuals in the course of daily life. According to Greenlee *et al.* (2001), the lifetime probability of developing cancer (*i.e.*, background cancer risk) is approximately 0.435 in men, and 0.383 in women. Cancer risks are expressed as a unitless probability (*e.g.*, one in a million, or 10^{-6}) of an individual developing cancer over a lifetime, above background risk, as a result of exposure to impacted environmental media at a site.

Excess (incremental) cancer risks for all of the exposure pathways (oral, dermal, and inhalation) are calculated using intake estimates (lifetime average daily doses, calculated in Section 3 as part of the exposure assessment) and CSFs (summarized as part of the toxicity assessment in Section 4) as follows (USEPA, 1989):

$$CancerRisk = Intake\left(\frac{mg}{kg \cdot day}\right) \times CSF\left(\frac{mg}{kg \cdot day}\right)^{-1}$$

For ingestion pathways, oral intake estimates (expressed as applied or administered dose levels) are multiplied by the oral CSF (applicable to applied/administered doses). Similarly, for inhalation pathways, inhalation intake estimates (also expressed as applied or administered dose levels) are multiplied by the inhalation CSF (applicable to applied/administered doses). For dermal exposures, dermal intake estimates (expressed as an absorbed dose level) are multiplied by an adjusted oral CSF (adjusted to apply to absorbed doses) (USEPA, 2004c). The total cancer risk for each receptor is the sum of the risks across all of the exposure pathways.

5.2 Calculation of Noncancer Risks

Risks from non-carcinogenic health effects are expressed as hazard quotients rather than as probabilities. A hazard quotient compares the calculated exposure (average daily doses, calculated as part of the exposure assessment in Section 3) to acceptable reference exposures derived by the USEPA (*e.g.*, RfDs, summarized as part of the toxicity assessment in Section 4). The hazard quotient is calculated from the RfD as follows (USEPA, 1989):

$$HazardQuotient = \frac{Intake\left(\frac{mg}{kg \cdot day}\right)}{RfD\left(\frac{mg}{kg \cdot day}\right)}$$

For the ingestion exposure route an oral intake estimate (expressed as applied or administered dose) is divided by the oral RfD (applicable to applied/administered dose). Similarly, for the inhalation exposure route an inhalation intake estimate (also expressed as applied or administered dose) is divided by the inhalation RfD (applicable to applied/administered dose). For dermal exposure, a dermal intake estimate (expressed as an absorbed dose) is divided by an adjusted oral RfD (adjusted to apply to absorbed dose).

Hazard indices are calculated for each receptor and exposure pathway, according to USEPA guidance (1989). A hazard index greater than 1.0 is considered to represent a significant health risk. Because a hazard quotient is simply a ratio of site exposures to reference exposure levels (*e.g.*, RfDs, RfCs, *etc.*), hazard indices do not represent the probability that an adverse health effect could occur. They simply indicate whether an estimated exposure for an individual presents a significant noncancer health risk, based on the USEPA's recommended reference dose.

5.3 Estimated Cancer and Noncancer Risks

The estimated cancer and noncancer risks for arsenic are discussed below by exposure area. Lead risks are discussed separately in Section 5.4. Cancer risks are summarized in Table 5. The total cancer risk for each receptor is the sum of the risks over all exposure routes and all exposure periods. Noncancer risks are also summarized in Table 5. The total noncancer risk for each receptor is the sum of the risks over all exposure routes. The detailed risk calculation tables in Appendix A present the arsenic risks calculated for each receptor and exposure pathway. The percent contribution of each exposure pathway to the total risk is also shown.

5.3.1 Main Facility Area

In the main facility area onsite, we evaluated two types of construction workers (Construction Workers 1 & 2) and a utility worker for exposure to arsenic in subsurface soil *via* incidental ingestion and dermal contact.

The total excess lifetime cancer risk is 7×10^{-6} for both construction workers, and 3×10^{-6} for the utility worker. These risk estimates are within USEPA's target risk range of 1×10^{-6} to 1×10^{-4}.

The total hazard index (HI) is 0.2 for Construction Worker 1, 1 for Construction Worker 2, and 0.05 for the utility worker. The remaining values are well below a HI of 1.0.

5.3.2 Grassy Area

In the grassy area located north, south, and east of the main facility, we evaluated a groundskeeper, a future site worker, two types of construction workers (Construction Workers 1 & 2), an adolescent trespasser exposed to soil, and an adolescent trespasser exposed to sediment. These receptors were assumed to be exposed to arsenic in soil or sediment *via* incidental ingestion and dermal contact.

The total excess lifetime cancer risks are 8×10^{-5} for the groundskeeper, 1×10^{-4} for the future site worker, 5×10^{-5} for both construction workers, 3×10^{-7} for the adolescent trespasser exposed to soil, and 7×10^{-6} for the adolescent trespasser exposed to sediment. These risk estimates are within or less than USEPA's target risk range of 1×10^{-6} to 1×10^{-4}.

The total hazard index (HI) is 0.5 for the groundskeeper, 0.7 for the future site worker, 2 for Construction Worker 1, 8 for Construction Worker 2, 0.01 for the adolescent trespasser exposed to soil, and 0.2 for the adolescent trespasser exposed to sediment. The two construction workers exceed a HI of 1.0. The other four receptors are below a HI of 1.0.

5.3.3 Arlington Avenue

In the Arlington Avenue area along the eastern border of the RMC property, we evaluated an adolescent recreator exposed to arsenic in surface sediment *via* incidental ingestion and dermal contact.

The total excess lifetime cancer risk for exposure to arsenic in sediment is 4×10^{-7} for the Arlington Avenue recreator. This risk estimate is below USEPA's target risk range of 1×10^{-6} to 1×10^{-4}.

The total hazard index (HI) for exposure to arsenic in sediment is 0.01 for the Arlington Avenue recreator. This value is well below a HI of 1.0.

5.3.4 Railroad Ditch

In the Railroad Ditch area along the northern border of RMC property, we evaluated an adolescent recreator exposed to arsenic in surface sediment *via* incidental ingestion and dermal contact.

The total excess lifetime cancer risk for exposure to arsenic in sediment is 2×10^{-6} for the Railroad Ditch recreator. This risk estimate is within USEPA's target risk range of 1×10^{-6} to 1×10^{-4}.

The total hazard index (HI) for exposure to arsenic in sediment is 0.05 for the Railroad Ditch recreator. This value is well below a HI of 1.0.

5.3.5 Offsite Natural Gas Facility

At the offsite natural gas facility to the west of the RMC property, we evaluated a facility worker exposed to arsenic in surface soil *via* ingestion and dermal contact.

The total excess lifetime cancer risk is 8×10^{-6} for the gas facility worker. This risk estimate is within USEPA's target risk range of 1×10^{-6} to 1×10^{-4}.

The total hazard index (HI) is 0.05 for the offsite gas facility worker. This value is well below a HI of 1.0.

Table 5
Summary of Cancer and Noncancer Risks

Exposure Area	Media	Receptors	Total Excess Lifetime Cancer Risk	Total Hazard Index
Plant Area	Soil	Construction Worker 1	7E-06	0.2
		Construction Worker 2	7E-06	1
	Soil	Utility Worker	3E-06	0.05
Grassy Area	Sediment	Adolescent Trespasser	7E-06	0.2
	Soil	Adolescent Trespasser	3E-07	0.01
	Soil and Sediment	Groundskeeper	8E-05	0.5
	Soil and Sediment	Future Site Worker	1E-04	0.7
		Construction Worker 1	5E-05	2
		Construction Worker 2	5E-05	8
Arlington Avenue	Sediment	Adolescent Recreator	4E-07	0.01
Railroad Ditch	Sediment	Adolescent Recreator	2E-06	0.05
Off Site Natural Gas Facility	Soil	Adult Worker	8E-06	0.05

5.4 Lead Risk Assessment

5.4.1 Adult Lead Model

Blood lead levels (BLLs) in adolescents and adults are assessed using USEPA's Adult Lead Model (ALM) (USEPA, 1996). USEPA's Adult Blood Lead Model predicts a median BLL estimate for an adult as a function of the baseline BLL plus an increment that is attributable to exposure to site soil. This increment is a function of the biokinetic slope factor, the concentration of lead in soil, the soil ingestion rate, the fraction of lead in soil that is absorbed, and the exposure frequency. EPA has selected a target BLL for an adult female, in order to protect a developing fetus such that no more than 5% of fetuses would be expected to have BLLs exceeding 10 μg/dL.

The basic form of the equation for the ALM is as follows:

$$BLL_{adult} = PbB + \frac{(EF \times AF \times PbS \times IR \times BKSF)}{AT}$$

The input values used in the model are summarized in Table 6 and described below. First, an average baseline lead concentration in blood (PbB_{base}) for adults is identified to account for continuing exposure to background levels of lead in food, soil, and dust, and pre-existing body burdens due to prior lead exposures. Baseline BLLs were obtained from the most recent National Health and Nutrition Examination Survey, from 1999-2000 (NHANES, 2000) (U.S. Public Health Service, 2004) (see Appendix E). For adults we used the geometric mean (GM) and geometric standard deviation (GSD) BLLs for women of childbearing age (age 20-49). For the adolescent trespasser, we used the GM and GSD BLLs for males and females combined, for 13-18 year olds. To this baseline, the model adds the incremental increase in blood lead due to the lead source of interest (in this case, exposure to lead *via* ingestion of soil).

The concentration of lead in soil (PbS) is the mean lead concentration in each exposure area. Lead uptake is calculated by multiplying the concentration of lead in soil by the soil ingestion rate (IR) and the absorption fraction (AF) for lead in soil. The AF is the amount of lead that is absorbed into the bloodstream from the gastrointestinal tract. The exposure frequency (EF) varies by receptor and exposure area. The EFs used for each receptor are presented in Table 3. The averaging time (AT) for chronic exposure to lead in soil is assumed to be one year (*i.e.*, 365 days). The biokinetic slope factor (BKSF) relates the incremental lead uptake into the body to an incremental increase in blood lead level in adults. USEPA's default value of 0.4 was used for the BKSF.

Table 6
Adult Lead Model Input Values

Term	Definition	Value
PbB_0	Geomean baseline BLL (μg/dL) for Adult females (age 20-49 yr) from NHANES 2000	1.2
GSD	Geometric standard deviation for Adult females	1.8
PbB_0	Geomean baseline BLL (μg/dL) for 13-18 yr old males and females	1.1
GSD	Geometric standard deviation for 13-18 yr old males and females	1.8
EF	Exposure Frequency (*i.e.*, number of days during the averaging time an individual is exposed to the lead source being evaluated (days))	Receptor-specific
AT	Averaging Time (days)	365
PbS	Soil lead concentration (μg/g)	Area-Specific
IR	Soil Ingestion Rate (g/day)	Receptor-specific 0.05 or 0.10
AF	Fraction of ingested lead absorbed into the blood stream (dimensionless)	0.12
BKSF	Biokinetic Slope Factor (change in blood lead per μg change in daily lead uptake) (μg/dL per μg/day)	0.4

Total BLLs for adults are predicted by adding the estimated incremental increase in blood lead to the average baseline BLL. A geometric standard deviation (GSD) appropriate for adults is used to estimate the probable range of BLLs around the predicted geometric mean adult BLL from the model. For this evaluation, we used the actual GSDs for the BLLs obtained from the NHANES-2000 database.

BLLs estimated using the ALM are evaluated based on a comparison to the USEPA risk management criterion for lead. Specifically, the health protection goal of the USEPA Office of Solid Waste and Emergency Response is to "limit exposure to soil lead levels such that a typical (or hypothetical) child or group of similarly exposed children would have an estimated risk of no more than 5% of exceeding a blood lead of 10 μg/dL" (USEPA, 1998). The Centers for Disease Control (CDC) recommend that "the goal of all lead poisoning prevention activities should be to reduce children's BLLs below 10 μg/dL" (CDC, 1991). Based on a goal of keeping the BLL in children at or below 10 μg/dL, the BLL for women of child-bearing age should not exceed 11.1 μg/dL, because the fetal BLL is approximately 90% of the maternal BLL (*i.e.*, 90% of 11.1 μg/dL is 10 μg/dL). A BLL goal of 10 μg/dL was used for the adolescent trespasser.

The adult lead modeling results for all receptors, along with the input values, the predicted BLLs, and the probability of exceeding the target BLL, are presented in Table 7. The adult lead modeling results are discussed below by exposure area. The dermal exposure route for lead in soil was not evaluated because this exposure route is typically insignificant when compared to ingestion. The ALM makes no provision for assessing dermal exposures.

Table 7
Summary of Lead Risks and Cleanup Goals

Exposure Variable	PbB Equation[1] 1*	2**	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario: Onsite Construction Worker 1	Onsite Construction Worker 2	Onsite Utility Worker	Grassy Area Grounds-keeper	Grassy Area Worker	Grassy Area Construction Worker 1
			Exposure Medium		Soil	Soil	Soil	Soil/Sed	Soil/Sed	Soil/Sed
			Soil Exposure Depth		0-5 ft	0-5 ft	0-5 ft	0-6"	0-6"	0-30"
PbS	X	X	Soil lead concentration	ug/g or ppm	20,266	20,266	20,266	20,158	20,158	13,392
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9	0.9	0.9
BKSF	X	X	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4	0.4	0.4	0.4	0.4
GSD_i	X	X	Geometric standard deviation PbB	--	1.8	1.8	1.8	1.8	1.8	1.8
PbB_0	X	X	Baseline PbB	ug/dL	1.2	1.2	1.2	1.2	1.2	1.2
IR_S	X		Soil ingestion rate	g/day	0.100	0.100	0.100	0.050	0.050	0.100
IR_{S+D}		X	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--	--	--	--	--
W_S		X	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--	--	--	--	--
K_{SD}		X	Mass fraction of soil in dust	--	--	--	--	--	--	--
$AF_{S,D}$	X	X	Absorption fraction	--	0.12	0.12	0.12	0.12	0.12	0.12
$EF_{S,D}$	X	X	Exposure frequency	days/yr	50	250	10	50	144	50
$AT_{S,D}$	X	X	Averaging time	days/yr	365	365	365	365	365	365
PbB_{adult}	PbB of adult worker, geometric mean			ug/dL	15	68	3.9	7.8	20	10
$PbB_{fetal,0.95}$	95th percentile PbB among fetuses of adult workers			ug/dL	34	161	9.1	19	48	24
PbB_t	Target PbB level of concern (e.g., 10 ug/dL)			ug/dL	10.0	10.0	10.0	10.0	10.0	10.0
$P(PbB_{fetal} > PbB_t)$	Probability that fetal PbB > PbB_t, assuming lognormal distribution			%	**68%**	**100%**	4%	**28%**	**85%**	**43%**
PRG	Preliminary Remediation Goal (PRG)			mg/kg	4601	920	--	9201	3195	4601
RAL	Remedial Action Level			mg/kg	78,900	8,470	--	73,900	16,665	43,300

Footnotes:
Construction Worker 1 is as described in the risk assessment work plan, i.e., short-term projects spread out over a 5 year period.
Construction Worker 2 presupposes redevelopment of the property including a year-long excavation/construction scenario for new buildings.

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

Table 7
Summary of Lead Risks and Cleanup Goals (cont'd)

Exposure Variable	PbB Equation[1] 1*	PbB Equation[1] 2**	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario: Grassy Area – Construction Worker 2	Grassy Area – Trespasser	Grassy Area – Trespasser	Arlington Ave – Recreator	Railroad Ditches – Recreator	Offsite Gas Facility – Worker
			Exposure Medium		Soil/Sed	Soil	Sediment	Sediment	Sediment	Soil
			Soil Exposure Depth		0-30"	0-6"	0-6"	0-3"	0-3"	0-6"
PbS	X	X	Soil lead concentration	ug/g or ppm	13,392	1,908	89,100	3032	5150	1311
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9	0.9	0.9
BKSF	X	X	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4	0.4	0.4	0.4	0.4
GSD_i	X	X	Geometric standard deviation PbB	--	1.8	1.8	1.8	1.8	1.8	1.8
PbB_0	X	X	Baseline PbB	ug/dL	1.2	1.1	1.1	1.1	1.1	1.2
IR_S	X		Soil ingestion rate	g/day	0.100	0.050	0.050	0.050	0.050	0.050
IR_{S+D}		X	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--	--	--	--	--
W_S		X	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--	--	--	--	--
K_{SD}		X	Mass fraction of soil in dust	--	--	--	--	--	--	--
$AF_{S,D}$	X	X	Absorption fraction	--	0.12	0.12	0.12	0.12	0.12	0.12
$EF_{S,D}$	X	X	Exposure frequency	days/yr	250	21	21	42	42	225
$AT_{S,D}$	X	X	Averaging time	days/yr	365	168	168	168	168	365
PbB_{adult}			PbB of adult worker, geometric mean	ug/dL	45	1.7	27.8	2.9	4.2	3.1
$PbB_{fetal,0.95}$			95th percentile PbB among fetuses of adult workers	ug/dL	107	4.0	65.9	6.9	9.9	7.4
PbB_t			Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	10.0	10.0	10.0	10.0	10.0	10.0
$P(PbB_{fetal} > PbB_t)$			Probability that fetal PbB > PbB_t, assuming lognormal distribution	%	**99%**	0.1%	**94%**	1%	5%	2%
PRG			Preliminary Remediation Goal (PRG)	ppm	920	--	10,417	--	--	--
RAL			Remedial Action Level		4,954	--	34,000	--	--	--

Footnotes: Construction Worker 1 is as described in the risk assessment work plan, i.e., short-term projects spread out over a 5 year period.
Construction Worker 2 presupposes redevelopment of the property including a year-long excavation/construction scenario for new buildings.
Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead
for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

5.4.2 Main Facility Area

In the main facility area, lead risks were evaluated for two types of construction workers and a utility worker exposed to subsurface soil (0-5 ft). The predicted 95th percentile fetal BLLs are 34 μg/dL for Construction Worker 1, 161 μg/dL for Construction Worker 2, and 9.1 μg/dL for the utility worker. The predicted BLL for the fetus of both construction workers exceeds the BLL goal of 10 μg/dL, thus lead in subsurface soil poses an unacceptable risk in the main facility area. The exceedance is due to the elevated subsurface soil EPC of 20,266 mg/kg, which represents the average concentration for depths of 0-5 ft across the site. The utility worker has a much lower exposure frequency than the construction worker, thus his predicted 95th percentile BLL is below the adult 95th percentile goal of 10 μg/dL.

5.4.3 Grassy Area

In the grassy area, lead risks were evaluated for a future site worker, a groundskeeper, two types of construction workers, an adolescent trespasser exposed to surface soil, and an adolescent trespasser exposed to sediment. The predicted 95th percentile fetal BLLs are 19 μg/dL for the groundskeeper, 48 μg/dL for the future site worker, 24 μg/dL for Construction Worker 1, 107 μg/dL for Construction Worker 2, 4 μg/dL for the trespasser exposed to soil, and 66 μg/dL for the trespasser exposed to sediment. The predicted fetal BLLs for all receptors except for the trespasser exposed to lead in soil exceed the BLL goal of 10 μg/dL, thus lead in soil and sediment poses an unacceptable risk in this exposure area.

5.4.4 Arlington Avenue

In the Arlington Avenue area, lead risks were evaluated for an adolescent recreator exposed to surface sediment. The predicted 95th percentile fetal BLL is 6.9 μg/dL for this adolescent recreator. The predicted BLL is below the goal of 10 μg/dL, therefore, lead does not pose a significant risk to a recreator exposed to surface sediment in this exposure area.

5.4.5 Railroad Ditch

In the Railroad Ditch area, lead risks were evaluated for an adolescent recreator exposed to surface sediment. The predicted 95th percentile fetal BLL is 9.9 μg/dL for this adolescent recreator. The predicted BLL is below the goal of 10 μg/dL, therefore, lead does not pose a significant risk to a recreator exposed to surface sediment in this exposure area.

5.4.6 Offsite Natural Gas Facility

At the offsite natural gas facility, lead risks were evaluated for an offsite worker exposed to surface soil. The predicted 95^{th} percentile fetal BLL is 7.4 μg/dL for the offsite worker. The predicted BLL is below the goal of 10 μg/dL, therefore, lead does not pose a significant risk to a worker exposed to surface soil in this exposure area.

5.5 Uncertainty Analysis

The process of evaluating human health risks involves multiple steps. Inherent in each step of the process are uncertainties that ultimately affect the final risk estimates. Uncertainties may exist in numerous areas, including sample collection, laboratory analysis, derivation of toxicity values, and estimation of potential site exposures. These uncertainties may result in either an over- or under-estimation of risks. However, for this risk assessment, where uncertainties existed, Gradient took a conservative approach in regards to parameters, assumptions, and methodologies, so as to overestimate potential exposures and risks. The most important contributors to uncertainty in this risk assessment are discussed below.

5.5.1 Uncertainties in Exposure Assessment

Soil Ingestion Rate. Lead risks were evaluated for onsite workers and grassy area construction workers using a soil ingestion rate of 0.10 g/day while all other receptors were evaluated using the 0.05 g/day default. The lead risks use an average soil ingestion rate, because average inputs are required by the ALM. Arsenic risks were evaluated using 0.330 g/day for the onsite and construction workers, 0.100 g/day for the groundskeeper, and 0.050 g/day for all other receptors. The arsenic risks use a high-end ingestion rate that represents the "reasonable maximum exposure" or RME. However, a survey of recent literature suggests that the average soil ingestion rate value for adults is closer to 0.02 g/day (Bowers *et al.*, 1994). Therefore, the soil ingestion rates used here are conservative in that they will tend to overestimate risk.

Lead Absorption Fraction. A lead absorption fraction used in the ALM was USEPA's default value of 0.12. This value is based on 20% absorption of lead from water, and 60% relative bioavailability of lead from soil (0.20 x 0.60 = 0.12). The 20% absorption of lead from water is an upper-end value based on consumption on an empty stomach. This is a conservative assumption that may overestimate risk. O'Flaherty (1993) suggests that a value of 8% may be a more appropriate absorption value for food and water in adults. This value assumes that people consume food at average mealtimes throughout the day, therefore the lead absorption rate is slower due to the presence of food in the stomach. If we use an adult soil ingestion rate of 0.02 g/day, combined with a lead absorption fraction of 8% (or for soil, 0.08 x 0.6 = 0.048), we find that the lead risks calculated for adult receptors could be on the order of 60-70% lower than those presented here. Thus the adult lead risks presented in this report are likely conservative overestimates.

Fraction from site. Each receptor's daily soil exposure was assumed to be solely from impacted soil within the exposure area. This is a conservative assumption, since it is expected that workers would be at the site for only 8 hours a day, and would be exposed to soil and dust from other sources during the remaining part of each day (*e.g.*, from home). For instance, in the grassy area, the exposure is likely overestimated for the future site worker, since we assumed he would obtain 100% of this daily soil ingestion during the hour or so that he visits the grassy area at lunchtime.

Exposure Duration. Gradient assumed an upper bound (95th percentile) exposure duration of 25 years for the future site worker, groundskeeper, and offsite gas facility worker (USEPA, 1991). This assumption is conservative and is likely to result in an overestimate of exposure and risk for most workers, since many workers do not remain at the same job for 25 years.

5.5.2 Uncertainties in Arsenic Risk Assessment

Risk management decisions for arsenic are confounded by the unusual nature of natural arsenic background risks, which for both food and water yield cancer risks of 10^{-4} or higher, and because of the substantial uncertainty associated with the arsenic cancer slope factor. This section describes some of the unique uncertainties associated with arsenic. In general, the assumptions we have used tend to overestimate arsenic risks.

5.5.2.1 Background Levels of Arsenic in Food, Water, Air, and Soil

Humans are exposed to low levels of arsenic in food, water, air, and soil (ATSDR, 2000). Food is typically the largest source of arsenic exposure, with dietary exposure accounting for about 70% of the daily intake of inorganic arsenic (Borum and Abernathy, 1994). The U.S. EPA estimates that the U.S. population ingests approximately 18 µg of inorganic arsenic every day from food (USEPA 1988). This translates into a 4×10^{-4} cancer risk estimate based on continuous lifetime exposure, and EPA's current assessment of the carcinogenic potential of arsenic.

In the U.S., the average background level of arsenic in drinking water is approximately 2 µg/L (ATSDR, 2000). The recent U.S. EPA rule allows a permissible level or maximum contaminant level (MCL) of 10 µg/L arsenic in drinking water (USEPA, 2001a), a 5-fold lower value than the prior MCL of 50 µg/L. The rule allows community and non-transient, non-community water systems 5 years to attain compliance with the new MCL. Assuming the average background level and an ingestion rate of 2 L drinking water per day, an adult would ingest 4 µg inorganic arsenic per day. At the new MCL of 10 µg/L, an adult would ingest 20 µg inorganic arsenic per day, while at the old MCL of 50 µg/L, an adult would ingest 100 µg inorganic arsenic per day. These values translate into a range of cancer risk estimates between 9×10^{-5} and 2×10^{-3} based on continuous lifetime exposure, and EPA's current assessment of the carcinogenic potential of arsenic. EPA currently estimates that approximately 11 million people in the U.S. are served by community water systems with arsenic levels above the revised MCL. These people therefore have a cancer risk from water alone above 4×10^{-4}.

The mean levels of arsenic in ambient air range from less than 1 to 3 ng/m^3 in rural areas and from 20 to 30 ng/m^3 in urban areas (ATSDR, 2000). Assuming an inhalation rate of 20 m^3/day, an adult would breathe in less than 0.02 to 0.06 µg inorganic arsenic per day in rural areas, and 0.4 to 0.6 µg in urban areas. Arsenic levels could be higher in urban areas due to emissions from coal-fired power plants. However, the maximum concentrations measured in a 24-hour period are generally below 100 ng/m^3 (ATSDR, 2000). These background values translate into a range of cancer risk estimates between 4×10^{-7} and 1×10^{-5}.

Background arsenic levels in soil in Indiana range from 3.6 to 15 mg/kg, with an average concentration of 7.5 mg/kg (Dragun and Chiasson, 1991).

Total cancer risk from a combination of background exposures to arsenic in food, water, air, and soil may be as high as between 10^{-4} and 10^{-3} for a substantial portion of the U.S. population.

5.5.2.2 Body Burdens of Arsenic

Soil arsenic has a modest impact on body burden, as evidenced by urinary arsenic levels. Although elevated urinary arsenic levels were reported to be associated with very high soil arsenic levels near copper smelters (Baker *et al.*, 1977; Binder *et al.*, 1987), several studies consistently demonstrated that very low urinary arsenic levels were produced from soil arsenic concentrations below 200 mg/kg. In addition, the Anaconda, MT study demonstrated that urinary arsenic levels were unaffected by soil arsenic levels as high as 500 mg/kg. This observation occurs in part because of the small impact of soil arsenic relative to the impact of background levels of arsenic in food and water.

5.5.2.3 Bioavailability of Arsenic in Soil

Another explanation for the minor impact of soil arsenic on body burdens of arsenic is that arsenic in soil has a relatively low bioavailability and is absorbed into the body (*i.e.*, bloodstream) less efficiently than arsenic in water, the form used by U.S. EPA for the arsenic cancer slope factor. The bioavailability of arsenic in soil depends on two steps: solubilization in gastrointestinal (GI) fluids and absorption across the GI epithelium into the bloodstream (Valberg *et al.*, 1997). Both the solubilization and absorption depend on a variety of factors including the chemical forms of arsenic, the mode of intake by the individual (with or without food, type of food), and the nutritional status, which affects the pH throughout the GI tract, and GI transit time.

The solubility of arsenic depends on soil particle size and the associated soil matrix materials. Particle size affects solubility because larger particles dissolve more slowly than smaller particles, hence, the percentage dissolved during GI transit time increases as particle size decreases. Solubility of arsenic may be limited when insoluble matrix minerals (*e.g.*, quartz) encase arsenic compounds. Similarly, formation of iron-arsenic oxides and phosphates, and prevalence of authigenic carbonate and silicate complexes also limit the solubility of arsenic (Davis *et al.*, 1992, 1996). The solubility in the GI tract is complex since the pH conditions change from low pH in the stomach to a much higher pH in the small intestine. Readily soluble arsenic compounds, such as arsenate and arsenite, are more bioavailable than poorly soluble arsenic compounds, such as arsenic trioxide (ATSDR, 2000).

Several animal studies have evaluated the bioavailability of soil-bound arsenic. Results from Freeman *et al.* (1993 and 1995) and Groen *et al.* (1994) indicated that soil-bound arsenic is not as bioavailable as arsenic in solution. The bioavailability of soil arsenic relative to aqueous arsenic administered by gavage was approximately 20 percent in monkeys and 48 percent in rabbits. The higher relative bioavailability in rabbits reflected the higher absolute bioavailability in this species. This was much lower than the 64 to 69 percent of arsenic recovered in urine after ingestion of dissolved arsenic by human volunteers (Johnson and Farmer, 1991). Casteel *et al.* (1997) conducted a multi-year investigation of bioavailability of metals in soil and mine wastes using young swine whose GI system is more similar to humans than other animals. The relative bioavailability of arsenic in soils at various mining and smelting sites ranged from 7 to 52%, which agreed with the results of previous studies by Freeman *et al.* and Groen *et al.* Rodriguez *et al.* (1999) performed a similar swine study that reported the range of 2.7 to 42.8% relative bioavailability of arsenic in soil. Based on Gradient's literature review, a relative bioavailability of 50% is the maximum value reported in any of the peer-reviewed, published arsenic bioavailability studies. This evaluation used a relative bioavailability of 80%, based on guidance from USEPA Region 10. The relative bioavailability of 80% is thus likely to overestimate arsenic risks.

5.5.2.4 Cancer Slope Factor (CSF) for Arsenic

Reports on arsenic toxicity in humans are largely based on exposure to arsenic compounds in media other than soil, for example, consumption of drinking water and inhalation in occupational settings. USEPA has derived toxicity factors, *i.e.*, reference dose (RfD) and cancer slope factor (CSF), for ingested arsenic based on data from a Taiwanese study evaluating the health effects associated with the consumption of water containing high concentrations of arsenic (Chen *et al.*, 1985; Tseng *et al.*, 1968). Although the application of the population data used to derive the RfD and CSF has been heavily debated (Carlson-Lynch *et al.*, 1994; Smith *et al.*, 1995; Beck *et al.*, 1995; Mushak and Crocetti, 1995, 1996; Slayton *et al.*, 1996), the values derived are generally believed to be conservative.

The CSF is based on skin cancer observed in a study of over 40,000 people in Taiwan who were exposed for a significant portion of their lifetime to elevated levels of arsenic in groundwater. Although the study clearly indicates an association between high levels of arsenic exposure and cancer, the study design limits its usefulness to derive precise dose-response relationships. The reasons are summarized below:

Exposure Assessment. There are considerable scientific concerns about the exposure estimates in the Taiwanese study (USEPA Region 6, 1998). Individual exposures were not characterized, and exposures were based on average arsenic concentrations of ground water in wells in each village. The amount of exposure was broadly classified into three groups (high, medium and low) and the original data were not available. The analytical method used to measure arsenic concentrations may not be accurate at low levels.

Human-to-Human Variation. In general, dose levels, genetic factors, dietary patterns, or other life style factors may alter arsenic metabolism and detoxification in different populations (USEPA Region 6, 1998). Taiwanese may be more susceptible than U.S. population, and therefore CSF based on Taiwanese population may overestimate cancer for U.S. population. The protein deficiencies in Taiwanese diets could affect their ability to methylate and therefore detoxify arsenic, leading to an increase in cancer risk. Consequently, extrapolation from one population to another becomes highly uncertain.

Other Sources of Exposure. When the U.S. EPA derived the CSF, they did not take into account other possible sources of arsenic in the Taiwanese diet (*e.g.*, from rice and yams) and dietary uses of drinking water. Hence, the assumptions used by the U.S. EPA in deriving toxicity values for arsenic underestimate the total arsenic intake, and as a result, the CSF may overestimate cancer risks.

Non-Linear Dose-Response. A recent U.S. EPA panel concluded that the dose-response for arsenic appeared to be non-linear (USEPA, 1997b), and the U.S. EPA Region 6 concluded that the available data "support a plausible threshold" (USEPA Region 6, 1998). The possible sub-linear or threshold dose-response relationship suggests that cancer risk at low doses of arsenic may be less than predicted based on a linear model.

Arsenic Differs in Water and Soil. Health effects associated with arsenic in water may not be relevant to assess the toxicity in soil (Valberg *et al.*, 1997). Arsenic exists in different chemical forms in water and soil, which may lead to potential differences in systemic bioavailability and dose-to-target organ. The relative proportion of overall arsenic intake and the correlation with urinary-arsenic concentrations may also be different between arsenic in water and soil. The differences will ultimately impact the overall potential for adverse health effects.

Overall, these uncertainties limit precise quantification of the dose-response relationship, but suggest the current CSF may overestimate cancer risks for a U.S. population exposed to lower levels of arsenic. Two recently published articles provide evidence that the CSF overestimates the cancer risk for arsenic as applied to drinking water studies outside the U.S. (Guo and Valberg, 1997) and within the U.S. (Valberg *et al.*, 1998). These papers report a meta-analysis of epidemiological studies evaluating the skin cancer incidence of 29 populations in India, Japan, Mexico, Taiwan and the U.S. who were exposed to 1.17 to 270 μg/L arsenic in water. The authors evaluated the validity of U.S. EPA arsenic CSF model to predict the expected number of skin cancers by conducting a likelihood ratio analysis. This analysis showed that a null hypothesis of no additional skin cancer risk from arsenic was approximately two times more likely than the hypothesis of the predicted rate of skin cancer from arsenic. This analysis indicated that the CSF derived from arsenic exposure in the Taiwanese populations is likely to be an overestimate when applied to the U.S. populations.

Additionally, in the epidemiological studies of a U.S. population that has been exposed to arsenic in drinking water, no increased cancer rate has been observed (USEPA Region 6, 1998). This is further supported by studies of individuals exposed to arsenic in soil who thus far have not indicated any toxicity (Binder *et al.*, 1987; Wong *et al.*, 1992).

5.5.2.5 Summary of Arsenic Risks and Uncertainty

Any effect of arsenic in soil on total arsenic body burden is difficult to observe as a result of the commonly reduced bioavailability of arsenic in soil, and the extent to which soil's contribution to body burden is overwhelmed by background levels of arsenic in food and water. Coupling these considerations with the uncertainty in the derivation of the arsenic cancer slope factor suggest that an acceptable risk level for soil arsenic may be close to 10^{-4}.

5.5.3 Uncertainties in Risk Characterization

Uncertainties associated with the first three steps of the risk assessment (data collection, exposure assessment, and toxicity assessment) are incorporated into the risk estimates in the risk characterization step. Although there are numerous uncertainties associated with this risk assessment, the incorporation of a large number of conservative assumptions has yielded risk estimates that are likely to overestimate actual site risks.

6 Soil Lead Cleanup Levels and Residual Risk

6.1 Soil Cleanup Levels

Lead risks are unacceptable for both construction workers in the main facility area, and the groundskeeper, the future site worker, both construction workers, and the trespasser exposed to sediment in the grassy area. Therefore, soil lead cleanup levels were calculated for these scenarios.

A preliminary remediation goal (PRG) is the average concentration in an exposure area that will result in an acceptable risk to a particular receptor. PRGs are risk-based target cleanup levels that must be met *on average* throughout the exposure area. It is acceptable to leave concentrations that exceed the cleanup level, so long as the post-remediation *average* concentration does not exceed the risk-based cleanup level.

The Remedial Action Level (RAL) is the concentration above which soil must be removed, so that the post-remediation *average* concentration meets the specified target cleanup level (USEPA, 2001b). The RAL is a remedial action goal (*i.e.,* a remediation trigger concentration) that ensures the post-remediation average concentration at a site achieves the target cleanup level with a specified level of confidence. It is important to note that the PRGs are specific to the receptor and exposure area for which they are developed, and the RALs are calculated with the specific dataset used to derive the EPC for that receptor. Therefore, it would not be appropriate to apply the lowest of all the PRGs or RALs to all of the exposure areas evaluated at the site. If the site was required to have only one PRG applicable to all areas, then all of the site data would need to be combined and assessed as one exposure unit.

According to U.S. EPA guidance, a risk-based cleanup is achieved when the post-remediation average concentration meets the risk-based cleanup level. The goal is to calculate a RAL so that the post-remediation average concentration will achieve the risk-based target cleanup level (the PRG) with a specified level of confidence. Gradient used a Confidence Removal Goal (CRG) algorithm (Bowers *et al.*, 1996)[2] to determine the RAL. The algorithm has been coded into a computer program which runs in Visual Basic. The CRG algorithm accounts for the inherent uncertainty in characterizing the soil concentration and

[2] Bowers, TS; Shifrin, NS; Murphy, BL. 1996. "Statistical approach to meeting soil cleanup goals." *Environ. Sci. Technol.* 30 (5) :1437-1444.

calculates the RAL so that there is a 95% certainty that the average of the post-remediation data (plus the clean replacement fill) will be less than or equal to the PRG. This method is described in USEPA, 2001b.

PRGs for lead are presented in Table 7 for the receptors with unacceptable lead risks. RALs were calculated for these receptors, assuming that excavated soil would be replaced with clean backfill containing lead at 50 mg/kg. In the main facility area, the RAL is 78,900 mg/kg for Construction Worker 1; this scenario assumes that Exide retains the property, and that several small construction projects are conducted over a 5 year period. In the main facility area, the RAL is 8,470 mg/kg for Construction Worker 2; this scenario assumes that the facility is sold and undergoes a one year redevelopment project involving subsurface excavation. In the grassy area, the RALs for surface soil (0 to 6 inches) are 73,900 mg/kg for the Groundskeeper, and 16,655 mg/kg for the Worker. In the grassy area, the RALs for subsurface soil and sediment combined (0 to 30 inches) are 43,300 mg/kg for Construction Worker 1, and 4954 mg/kg for Construction Worker 2. In the grassy area, the RAL for sediment alone is 34,000 mg/kg for the Trespasser. Appendix B shows the sample locations that would be subject to remediation for the scenario with the lowest RAL in each exposure area. The governing lead RAL for each exposure area is presented in Table 8. Appendix B shows that after removal of these samples, and replacement with clean fill, the average of the post-remedial data points is less than the PRG.

Table 8
Governing Lead RAL for Each Exposure Area

Exposure Area	Media	Receptor	Lead RAL (mg/kg)
Onsite Main Facility Area	Soil (0-5 ft)	Construction Worker 1 (Property retained by Exide)	78,900
Onsite Main Facility Area	Soil (0-5 ft)	Construction Worker 2 (Property sold)	8,470
Grassy Area	Soil and Sediment (0-6")	Future Site Worker	16,665
Grassy Area	Soil and Sediment (0-30")	Construction Worker 1 (Property retained by Exide)	43,300
Grassy Area	Soil and Sediment (0-30")	Construction Worker 2 (Property sold)	4,954
Grassy Area	Sediment (0-6")	Adolescent Trespasser	34,000

6.2 Post-Remediation Residual Risk

Lead and arsenic concentrations are generally correlated, therefore, rather than calculate PRGs and RALs for arsenic, we considered the effects of lead remediation on the arsenic risks. The residual risk from arsenic was calculated assuming that soil was remediated for lead in the main facility area and the grassy area. Residual arsenic risks were calculated for the receptors that had a cancer risk greater than 1×10^{-5}, or a hazard index greater than 1.0 (Table 9). The post-remediation arsenic data sets are presented in Appendix D. We used the lead RALs that corresponded to the receptors listed in Table 9. The post-remediation arsenic EPCs were calculated (using ProUCL) assuming that excavated soil was replaced with clean backfill containing arsenic at 5 mg/kg (Table 9 and Appendix D). Residual cancer risks range from 1×10^{-6} to 7×10^{-6}, and residual noncancer risks range from 0.03 to 0.2 (Table 9). On the basis of this analysis, PRGs and RALs for arsenic are not needed and were therefore not calculated.

Table 9
Summary of Post-Remediation Risks for Arsenic

	Pre-Remediation			Post-Remediation		
Receptor/Exposure Pathway	Arsenic EPC (mg/kg)	Cancer Risk	Hazard Index	Arsenic EPC (mg/kg)	Cancer Risk	Hazard Index
Onsite Construction Worker 2	123	7E-06	1	15.9	9E-07	0.1
Grassy Area Groundskeeper	779	7E-05	0.4	49.2	4E-06	0.03
Grassy Area Site Worker	779	1E-04	0.7	49.2	7E-06	0.04
Grassy Area Construction Worker 1	818	5E-05	2	24.0	1E-06	0.04
Grassy Area Construction Worker 2	818	5E-05	8	24.0	1E-06	0.2

7 Conclusions

Cancer risks attributable to arsenic were calculated for receptors in five exposure areas. All of the calculated cancer risks fall within or below USEPA's target risk range of 1×10^{-6} to 1×10^{-4}. Cancer risks ranged from 3×10^{-7} to 1×10^{-4}. The exposure scenario with the highest excess lifetime cancer risk is the future site worker in the grassy area (1×10^{-4}). The exposure pathway with the greatest contribution to cancer risk is soil ingestion.

Noncancer risks attributable to arsenic were calculated for receptors in five exposure areas. Noncancer risks exceeded USEPA's target hazard index of 1.0 for the onsite Construction Worker 2; and Construction Workers 1 and 2 in the grassy area. The exposure scenario with the highest noncancer risk is the grassy area Construction Worker 2 (HI of 7.6). The exposure pathway with the greatest contribution to noncancer risk is soil ingestion.

Lead risks were evaluated for adult and/or adolescent receptors in five exposure areas. Lead risks were evaluated by comparing the predicted fetal BLL for each receptor to USEPA's BLL goal of 10 µg/dL. Predicted 95th percentile fetal BLLs exceeded USEPA goals for the following receptors: Construction Workers 1 and 2 in the main facility area, the groundskeeper and future site worker exposed to surface soil in the grassy area, Construction Workers 1 and 2 exposed to subsurface soil in the grassy area, and the Trespasser exposed to sediment in the grassy area. The predicted 95th percentile fetal BLL did not exceed the USEPA goal for the following receptors: the Utility Worker in the main facility area, the Trespasser exposed to soil in the grassy area, the Recreator in the Railroad Ditch, the Recreator along Arlington Ave, and the Offsite Gas Facility Worker.

PRGs and RALs were calculated for lead, for the receptors with unacceptable lead risks. In the main facility area onsite, the RAL is 78,900 mg/kg for Construction Worker 1, and 8,470 mg/kg for Construction Worker 2. For grassy area surface soil, the RAL is 73,900 mg/kg for the Groundskeeper, and 16,655 mg/kg for the Site Worker. For grassy area subsurface soil and sediment combined, the RAL is 43,300 mg/kg for Construction Worker 1, and 4954 mg/kg for Construction Worker 2. For the grassy area sediment alone, the RAL is 34,000 mg/kg for the Trespasser.

The residual risk from arsenic was calculated assuming that soil was remediated for lead in the main facility area and the grassy area. Residual cancer risks range from 9×10^{-7} to 7×10^{-6}. Residual noncancer risks range from 0.03 to 0.2. All post-remediation residual risks for arsenic are within or below EPA's target risk range for cancer and non-cancer risks.

8 References

Abernathy, CO; Marcus, W; Chen, C; *et al.* 1989. Internal Memorandum to P. Cook/P. Preuss re: Report on Arsenic (As) Work Group Meetings. US EPA, Office of Drinking Water, Washington, DC.

Advanced GeoServices Corp. (AGC). 2000. Advanced GeoServices Corp. RCRA Facility Investigation Report. Prepared for Refined Metals Corp., Beech Grove, IN. August 31.

Advanced GeoServices Corp. (AGC). 2003. Final Phase II RCRA Facility Investigation Report. Prepared for Refined Metals Corp., Beech Grove, IN. February 4.

Agency for Toxic Substances and Disease Registry (ATSDR). 1999. "Toxicological Profile for Lead (Update)." Report to US Public Health Service, Agency for Toxic Substances and Disease Registry (ATSDR) National Technical Information Service (NTIS), Springfield, VA. NTIS PB99-166704. July.

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. "Toxicological Profile for Arsenic (Update.)" National Technical Information Service, Springfield, VA. Prepared for US Public Health Service, Agency for Toxic Substances and Disease Registry (ATSDR). NTIS PB2000-108021. 446p. September.

Baker, E; Hayes, C; Landrigan, P; Handke, J; Leger, R; Houseworth W; Harrington, J. 1977. A nationwide survey of heavy metal absorption in children living near primary copper, lead, and zinc smelters. *Am. J. Epidemiol.* 106(4):261-273.

Beck, BD; Boardman, PD; Hook, GC; Rudel, RA; Slayton, TM; Carlson-Lynch, H. 1995. Correspondence: Response to Smith *et al. Environ. Health Perspect.* 103(1):15-16.

Binder, S; Forney, D; Kaye, W; Paschal, D. 1987. Arsenic exposure in children living near a former copper smelter. *Bull. Environ. Contam. Toxicol.* 39:114-121.

Borum, DR; Abernathy, CO. 1994. Human oral exposure to inorganic arsenic. In *Arsenic, Exposure and Health* (Eds: Chappell, WR; Abernathy, CO; Cothern, CR). Science and Technology Letters, Northwood, England, p 21-29.

Bowers, TS; Beck, BD; Karam, HS. 1994. Assessing the relationship between environmental lead concentrations and adult blood lead levels. *Risk Analysis* 14(2):183-189.

Carlson-Lynch, H; Beck, BD; Boardman, PD. 1994. Arsenic risk assessment: A commentary. *Environ. Health Perspect.* 102(4):354-356.

Casteel, SW; Brown, LD; Dunsmore, ME; Weis, CP; Henningsen, GM; Hoffman, E; Brattin, WJ; Hammon, TL. 1997. Relative bioavailability of arsenic in mining wastes. Report to EPA, Region 8.

Centers for Disease Control (CDC). 1991. "Draft CDC Lead Statement: Preventing Lead Poisoning in Young Children." March.

Chappell, WR; Beck, BD; Brown, KG; Chaney, R; Cothern, CR; Irgolic, KJ; North, DW; Thornton, I; Tsongas, TA. 1997. Inorganic arsenic: A need and an opportunity to improve risk assessment. *Environmental Health Perspectives* 105(10):1060-1067.

Chen, C-J; Chuang, Y-C; Lin, T-M; Wu, H-Y. 1985. Malignant neoplasms among residents of a blackfoot disease-endemic area in Taiwan: High arsenic artesian well water and cancers. *Cancer Res.* 45:5895-5899.

Davis, A; Ruby, MV; Bergstrom, PD. 1992. Bioavailability of arsenic and lead in soils from the Butte, Montana, mining district. *Environmental Science and Technology* 26(3):461-468.

Davis, A; Ruby, MV; Bloom, M; Schoof, R; Freeman, G; Bergstrom, PD. 1996. Mineralogic constraints on the bioavailability of arsenic in smelter-impacted soils. *Environ. Sci. and Technol.* 30(2):392-399.

Dragun, J; Chiasson, A. 1991. *Elements in North American Soils.* Hazardous Materials Control Resources Institute, Maryland, 238p.

Freeman, GB; Johnson, JD; Killinger, JM; Liao, SC; Davis, AO; Ruby, MV; Chaney, RL; Lovre, SC; Bergstrom, PD. 1993. Bioavailability of arsenic in soil impacted by smelter activities following oral administration in rabbits. *Fundamental Applied Toxicology* 21:83-88.

Freeman, G; Schoof, R; Ruby, M; Davis, A; Dill, J; Liao, S; Lapin, C; Bergstrom, P. 1995. Bioavailability of arsenic in soil and house dust impacted by smelter activities following oral administration in cynomolgus monkeys. *Fundamental Applied Toxicology* 28:215-222.

Greenlee, RT; Hill-Harmon, MB; Murray, T; Thun, M. 2001. Cancer statistics, 2001. *CA Cancer J. Clin.* 51:15-36.

Groen, K, Vaessen, HAMG; Kliest, JJG; deBoer, JLM; van Ooik, T; Timmerman, A; Vlug, RF. 1994. Bioavailability of arsenic from bog ore-containing soil in the dog. *Environ. Health Perspect.* 102(2):182-184.

Guo, HR; Valberg, PA. 1997. Evaluation of the validity of the US EPA's cancer risk assessment of arsenic for low-level exposures: A likelihood ratio approach. *Environ. Geochem. Health* 19:133-141.

Johnson, LR; Farmer, JG. 1991. Use of human metabolic studies and urinary arsenic speciation in assessing arsenic exposure. *Bull. Environ. Contam. Toxicol.* 46:53-61.

Mushak, P; Crocetti, AF. 1995. Commentary: Risk and revisionism in arsenic cancer risk assessment. *Environ. Health Perspect.* 103(7-8):684-689.

Mushak, P; Crocetti, AF. 1996. Correspondence-Response: Accuracy, arsenic, and cancer. *Environ. Health Perspect.* 104(10):1014-1018.

O'Flaherty, EJ. 1993. Physiologically based models for bone-seeking elements. IV. Kinetics of lead disposition in humans. *Toxicol. Appl. Pharmacol.* 118 :16-29.

Rodriguez, RR; Basta, NT; Casteel, SW; Pace, LW. 1999. An *in vitro* gastrointestinal method to estimate bioavailable arsenic in contaminated soils and solid media. *Environ. Sci. and Technol.* 33(4):642-649.

Slayton, TM; Beck, BD; Reynolds, KA; Chapnick, SD; Valberg, PA; Yost, LJ; Schoof, RA; Gauthier, TD; Jones, L. 1996. Correspondence: issues in arsenic cancer risk assessment. *Environ. Health Perspect.* 104(10):1012–1014.

Smith, AH; Biggs, M-L; Hopenhayn-Rich, C; Kalman, D. 1995. Correspondence: Arsenic risk assessment. *Environ. Health Perspect.* 103(1):13-15.

Tseng, WP; Chu, HM; How, SW. 1968. Prevalence of skin cancer in an endemic area of chronic arsenicism in Taiwan. *J. Nat. Cancer Inst.* 3:453(10).

Tseng, WP. 1977. Effects and dose response relationships of skin cancer and blackfoot disease with arsenic. *Environ. Health Perspect.* 19:109-119.

U.S. Environmental Protection Agency (USEPA). 1988. "Special Report on Ingested Inorganic Arsenic - Skin Cancer: Nutritional Essentiality." EPA/625/3-87/013. July.

U.S. Environmental Protection Agency (USEPA). 1989. "Risk Assessment Guidance for Superfund (RAGS), Vol. I, Human Health Evaluation Manual (Part A)." Office of Emergency and Remedial Response, Washington, D.C. OSWER Directive 9285.7-01A. EPA-540/1-89-002. December.

U.S. Environmental Protection Agency (USEPA). 1991. "Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual. Supplemental Guidance: Standard Default Exposure Factors. Interim Final." Office of Emergency and Remedial Response, Toxics Integrations Branch, Washington, DC. OSWER Directive: 9285.6-03. March 25.

U.S. Environmental Protection Agency (USEPA). 1992a. "Dermal Exposure Assessment: Principals and Applications, Interim Report." Exposure Assessment Group, Office of Health and Environmental Assessment, Washington, DC. EPA/600/8-91/011B.

U.S. Environmental Protection Agency (USEPA). 1992b. "Supplemental Guidance to RAGS: Calculating the Concentration Term." Office of Solid Waste and Emergency Response, Washington, DC. PB92-963373. May.

U.S. Environmental Protection Agency (USEPA). 1992c. Integrated Risk Information System (IRIS): EPA's Approach for Assessing the Risks Associated with Chronic Exposures to Carcinogens. Background Document 2. January 17. Downloaded from www.epa.gov/ngispgm3/iris/carcino.htm on January 11, 2001.

U.S. Environmental Protection Agency (USEPA). 1993. "Integrated Risk Information System (IRIS): Reference Dose (RfD): Description and Use in Health Risk Assessments. Background Document 1A." March 15. Downloaded from www.epa.gov/ ngispgm3/iris/rfd.htm on January 11, 2001.

U.S. Environmental Protection Agency (USEPA). 1994. "Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children." US EPA, Technical Review Workgroup for Lead. Prepared for UP EPA, Office of Emergency and Remedial Response, Research Triangle Park, NC. OERR Publication 9285.7-15-1; EPA540-R-93-081; NTIS PB93-963510. February.

U.S. Environmental Protection Agency (USEPA). 1996. "Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil." Technical Review Workgroup for Lead. December.

U.S. Environmental Protection Agency (USEPA). 1997a. "Exposure Factors Handbook. Volumes I, II, III." Office of Research and Development, Washington, DC. EPA/600/P-95/002Fa-c. August.

U.S. Environmental Protection Agency (USEPA). 1997b. "Report on the Expert Panel on Arsenic Carcinogenicity: Review and Workshop." National Center for Environmental Assessment, Washington, DC. August.

U.S. Environmental Protection Agency (USEPA). 1998. "Clarification to the 1994 Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities." Office of Solid Waste and Emergency Response. OSWER Directive #9200.4-27, EPA/540/F-98-030. August.

U.S. Environmental Protection Agency (USEPA). 2001a. "Drinking Water Standards for Arsenic." Office of Water. EPA 815-F-00-015. January.

U.S. Environmental Protection Agency (USEPA). 2001b. "Risk Assessment Guidance for Superfund (RAGS). Volume III: Part A, Process for Conducting Probabilistic Risk Assessment." Office of Emergency and Remedial Response, Washington, DC. EPA 540-R-02-002; Publication 9285.7-45; PB2002-963302. 385p. December.

U.S. Environmental Protection Agency (USEPA). 2002a. "Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites [Supplemental Guidance to RAGS.]" Office of Emergency and Remedial Response (Washington, DC). OSWER Directive 9285.6-10. 32p. December. Downloaded from http://www.epa.gov/superfund/programs/risk/ragsa/ucl.pdf.

U.S. Environmental Protection Agency (USEPA). 2002b. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Emergency and Remedial Response. OSWER 9355.4-24. December.

U.S. Environmental Protection Agency (USEPA). 2003. "Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil." Technical Review Workgroup for Lead. Report to US EPA, Office of Solid Waste and Emergency Response/Office of Emergency and Remedial Response, Washington, DC. EPA-540-R-03-001; OSWER Directive 9285.7-54. January. Downloaded from http://www.epa.gov/superfund/programs/lead/products/adultpb.pdf.

U.S. Environmental Protection Agency (USEPA). 2004a. Integrated Risk Information System (IRIS). Arsenic, Inorganic. Downloaded from http://www.epa.gov/iris/subst/0278.htm

U.S. Environmental Protection Agency (USEPA). 2004b. Integrated Risk Information System (IRIS). Lead and Compounds (Inorganic). Downloaded from http://www.epa.gov/IRIS/subst/0277.htm.

U.S. Environmental Protection Agency (USEPA). 2004c. "Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual. Part E. Supplemental Guidance for Dermal Risk Assessment. Final." Office of Emergency and Remedial Response, Washington, DC. EPA/540/R/99/005. OSWER 9285.7-02EP. PB99-963312. July.

U.S. Environmental Protection Agency Region 6 (USEPA Region 6). 1998. "Region 6 Interim Strategy: Arsenic – Freshwater Human Health Criterion for Fish Consumption, Appendix B: Health Effects of Arsenic." Downloaded from http://www.epa.gov/earth1r6/6wq/ecopro/watershd/standard/arsenic.htm on May 6, 1998. Page last updated February 4, 1998.

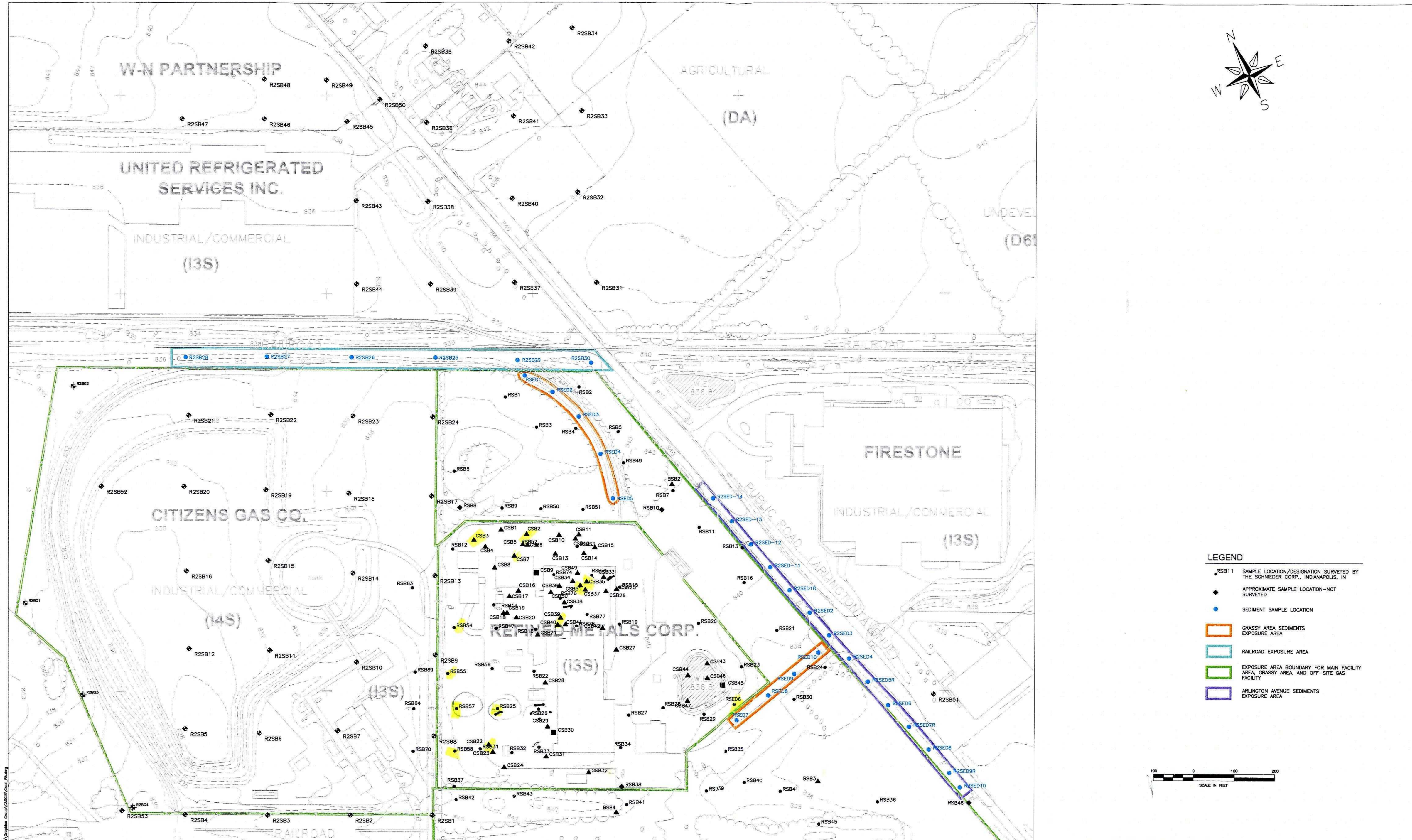
U.S. Environmental Protection Agency Region 10 (USEPA Region 10). 1997. "Supplemental Ecological Risk Assessment Guidance for Superfund." Office of Environmental Assessment, Risk Evaluation Unit. EPA 910-R-97-005. June.

U.S. Public Health Service. 2004. "National Health and Nutrition Examination Survey, 1999-2000. (NHANES, 2000). National Center for Health Statistics. Downloaded from http://www.cdc.gov/nchs/about/major/nhanes/NHANES99_00.htm - Laboratory%20Files.

Valberg, PA; Beck, BD; Bowers, TS; Keating, JL; Bergstrom, PD; Boardman, PD. 1997. Issues in setting health-based cleanup levels for arsenic in soil. *Regul Toxicol Pharmacol* 26:219-229.

Valberg, PA; Beck, BD; Boardman, PD; Cohen, JT. 1998. Likelihood ratio analysis of skin cancer prevalence associated with arsenic in drinking water in the USA. *Environ. Geochem. Health* 20:61-66.

Wong, O; Whorton, MD; Foliart, DE; Lowengart, R. 1992. An ecologic study of skin cancer and environmental arsenic exposure. *Int. Arch. Occup. Environ. Health* 64:235-241.



MAP SOURCE: REFINED METALS CORPORATION, CORRECTIVE MEASURES STUDY WORK PLAN – DRAWING 1

Date:	03/29/05 (JJC)	RISK ASSESSMENT EXPOSURE AREAS	DRAWING:
Scale:	1"=100'		1
Drawn By:	P.S.G.		
Checked By:	P.G.S.	Advanced GeoServices Corp.	
Project Mgr.:	P.G.S.	Chadds Ford Business Campus, Rts. 202 & 1	
Project No.:	2003-1046-04	Brandywine One, Suite 202	
Dwg No.		Chadds Ford, Pennsylvania 19317	
Issued:			

Appendix A

Risk Calculation Tables

Appendix A
Arsenic Risk Summary

Receptor/Exposure Pathway		Cancer Risk	Hazard Index	Percent Contribution
Onsite Construction Worker 1				
Dermal Contact with Soil		5.1E-07	0.016	7%
Ingestion of Soil		6.8E-06	0.21	93%
	Total:	**7E-06**	**0.2**	
Onsite Construction Worker 2				
Dermal Contact with Soil		5.1E-07	0.08	7%
Ingestion of Soil		6.8E-06	1.1	93%
	Total:	**7E-06**	**1**	
Onsite Utility Worker				
Dermal Contact with Soil		2.0E-07	0.0032	7%
Ingestion of Soil		2.7E-06	0.042	93%
	Total:	**3E-06**	**0.05**	
Grassy Area Groundskeeper				
Dermal Contact with Soil and Sediment		1.6E-05	0.10	20%
Ingestion of Soil and Sediment		6.5E-05	0.41	80%
	Total:	**8E-05**	**0.5**	
Grassy Area Site Worker				
Dermal Contact with Soil and Sediment		1.6E-05	0.10	15%
Ingestion of Soil and Sediment		9.4E-05	0.59	85%
	Total:	**1E-04**	**0.7**	
Grassy Area Construction Worker 1				
Dermal Contact with Soil and Sediment		3.4E-06	0.11	7%
Ingestion of Soil and Sediment		4.5E-05	1.4	93%
	Total:	**5E-05**	**2**	
Grassy Area Construction Worker 2				
Dermal Contact with Soil and Sediment		3.4E-06	0.53	7%
Ingestion of Soil and Sediment		4.5E-05	7.04	93%
	Total:	**5E-05**	**8**	
Grassy Area Trespasser Adolescent 1				
Dermal Contact with Soil		5.7E-08	0.0018	18%
Ingestion of Soil		2.6E-07	0.0079	82%
	Total:	**3E-07**	**0.01**	
Grassy Area Trespasser Adolescent 2				
Dermal Contact with Sediment		1.3E-06	0.041	18%
Ingestion of Sediment		5.9E-06	0.18	82%
	Total:	**7E-06**	**0.2**	

Appendix A
Arsenic Risk Summary

Receptor/Exposure Pathway		Cancer Risk	Hazard Index	Percent Contribution
Arlington Ave Adolescent Recreator				
Dermal Contact with Sediment		7.2E-08	0.0023	18%
Ingestion of Sediment		3.2E-07	0.010	82%
	Total:	**4E-07**	**0.01**	
Railroad Ditch Adolescent Recreator				
Dermal Contact with Sediment		3.2E-07	0.010	18%
Ingestion of Sediment		1.4E-06	0.045	82%
	Total:	**2E-06**	**0.05**	
Offsite Gas Facility Worker				
Dermal Contact with Soil		2.7E-06	0.017	33%
Ingestion of Soil		5.4E-06	0.033	67%
	Total:	**8E-06**	**0.05**	

Appendix A
Excess Lifetime Cancer Risk by Chemical And Pathway for All Receptors

Ingestion of Soil and/or Sediment containing Arsenic

Exposure Areas and Receptors	Matrix	Arsenic Concentration (C) mg/kg	Intake Factor (IF)	Bioavailability (R)	Daily Intake DI = CxIFxR (mg/kg-day)	Slope Factor (SF) (kg-day/mg)	Total Cancer Risk CR = DIxSF
Onsite Construction Worker 1	Soil	123	4.6E-08	0.8	4.5 5.7E-06	1.5	6.8E-06
Onsite Construction Worker 2	Soil	123	4.6E-08	0.8	4.5 5.7E-06	1.5	6.8E-06
Onsite Utility Worker	Soil	123	1.8E-08	0.8	2.3E-06	1.5	2.7E-06
Grassy Area Groundskeeper	Soil and Sediment	779	7.0E-08	0.8	5.4E-05	1.5	6.5E-05
Grassy Area Future Industrial Site Worker	Soil and Sediment	779	1.0E-07	0.8	6.2 ~~7.8E-05~~	1.5	9.4E-05 (1.4e-4)
Grassy Area Construction Worker 1	Soil and Sediment	818	4.6E-08	0.8	3.8E-05	1.5	4.5E-05
Grassy Area Construction Worker 2	Soil and Sediment	818	4.6E-08	0.8	3.8E-05	1.5	4.5E-05
Grassy Area Adolescent Trespasser	Soil	60	3.5E-09	0.8	2.1E-07	1.5	2.6E-07
Grassy Area Adolescent Trespasser	Sediment	1387	3.5E-09	0.8	3.8 4.9E-06	1.5	5.9E-06
Arlington Ave Adolescent Recreator	Sediment	38	7.1E-09	0.8	2.7E-07	1.5	3.2E-07
Railroad Ditches Adolescent Recreator	Sediment	169	7.1E-09	0.8	1.2E-06	1.5	1.4E-06
Offsite Gas Facility Worker	Soil	29	1.6E-07	0.8	4.5E-06	1.5	5.4E-06

Notes:

IF = Intake Factor (IR * FS * EF * ED * CF) / (BW * AT) =
AT = Averaging Time - Cancer (d) = 25550
BW = Body Weight (kg)
CF = Conversion Factor (kg/mg)
ED = Exposure Duration (yrs)
EF = Exposure Frequency (d/yr)
FS = Fraction from Contaminated Source
IR = Ingestion Rate (mg/d)

Appendix A
Excess Lifetime Cancer Risk by Chemical And Pathway for All Receptors

Dermal Contact with Soil and/or Sediment containing Arsenic

Exposure Areas and Receptors	Matrix	Arsenic Concentration (C) mg/kg	Intake Factor (IF)	Dermal Absorption (A)	Daily Intake DI = CxIFxA (mg/kg-day)	Slope Factor (SF) (kg-day/mg)	Total Cancer Risk CR = DIxSF
Onsite Construction Worker 1	Soil	123	9.2E-08	3.0E-02	3.4E-07	1.5	5.1E-07
Onsite Construction Worker 2	Soil	123	9.2E-08	3.0E-02	3.4E-07	1.5	5.1E-07
Onsite Utility Worker	Soil	123	3.7E-08	3.0E-02	1.4E-07	1.5	2.0E-07
Grassy Area Groundskeeper	Soil and Sediment	779	4.6E-07	3.0E-02	1.1E-05	1.5	1.6E-05
Grassy Area Future Industrial Site Worker	Soil and Sediment	779	4.6E-07	3.0E-02	1.1E-05	1.5	1.6E-05
Grassy Area Construction Worker 1	Soil and Sediment	818	9.2E-08	3.0E-02	2.3E-06	1.5	3.4E-06
Grassy Area Construction Worker 2	Soil and Sediment	818	9.2E-08	3.0E-02	2.3E-06	1.5	3.4E-06
Grassy Area Adolescent Trespasser	Soil	60	2.1E-08	3.0E-02	3.8E-08	1.5	5.7E-08
Grassy Area Adolescent Trespasser	Sediment	1387	2.1E-08	3.0E-02	8.8E-07	1.5	1.3E-06
Arlington Ave Adolescent Recreator	Sediment	38	4.2E-08	3.0E-02	4.8E-08	1.5	7.2E-08
Railroad Ditches Adolescent Recreator	Sediment	169	4.2E-08	3.0E-02	2.1E-07	1.5	3.2E-07
Offsite Gas Facility Worker	Soil	29	2.1E-06	3.0E-02	1.8E-06	1.5	2.7E-06

Notes:

IF = Intake Factor (AF * SA * EF * ED * CF) / (BW * AT) =
AT = Averaging Time - Cancer (d) = 25550
BW = Body Weight (kg)
CF = Conversion Factor (kg/mg)
ED = Exposure Duration (yrs)
EF = Exposure Frequency (d/yr)
SA = Surface Area Exposed to Soil and/or Sediment (cm^2/event)
AF = Soil and/or Sediment/Skin Adherence Factor (mg/cm^2)

Appendix A
Noncancer Hazard Quotient by Chemical And Pathway for All Receptors

Ingestion of Soil and/or Sediment containing Arsenic

Exposure Areas and Receptors	Matrix	Arsenic Concentration (C) mg/kg	Intake Factor (IF)	Bioavailability (R)	Daily Intake DI = CxIFxR (mg/kg-day)	Reference Dose (RfD) (mg/kg-day)	Hazard Quotient HQ=DI÷RfD
Onsite Construction Worker 1	Soil	123	6.5E-07	0.8	6.5E-07	3.00E-04	2.1E-01
Onsite Construction Worker 2	Soil	123	3.2E-06	0.8	3.2E-06	3.00E-04	1.1E+00
Onsite Utility Worker	Soil	123	1.3E-07	0.8	1.3E-07	3.00E-04	4.2E-02
					1.2e-4		
Grassy Area Groundskeeper	Soil and Sediment	779	2.0E-07	0.8	2.0E-07	3.00E-04	4.1E-01
Grassy Area Future Industrial Site Worker	Soil and Sediment	779	2.8E-07	0.8	2.8E-07	3.00E-04	5.9E-01
Grassy Area Construction Worker 1	Soil and Sediment	818	6.5E-07	0.8	6.5E-07	3.00E-04	1.4E+00
Grassy Area Construction Worker 2	Soil and Sediment	818	3.2E-06	0.8	3.2E-06	3.00E-04	7.0E+00
Grassy Area Adolescent Trespasser	Soil	60	5.0E-08	0.8	5.0E-08	3.00E-04	7.9E-03
Grassy Area Adolescent Trespasser	Sediment	1387	5.0E-08	0.8	5.0E-08	3.00E-04	1.8E-01
Arlington Ave Adolescent Recreator	Sediment	38	9.9E-08	0.8	9.9E-08	3.00E-04	1.0E-02
Railroad Ditches Adolescent Recreator	Sediment	169	9.9E-08	0.8	9.9E-08	3.00E-04	4.5E-02
Offsite Gas Facility Worker	Soil	29	4.4E-07	0.8	4.4E-07	3.00E-04	3.3E-02

Notes:

IF = Intake Factor (IR * FS * EF * ED * CF) / (BW * AT) =
AT = Averaging Time - Noncancer (d) = ED * EF
BW = Body Weight (kg)
CF = Conversion Factor (kg/mg)
ED = Exposure Duration (yrs)
EF = Exposure Frequency (d/yr)
FS = Fraction from Contaminated Source
IR = Ingestion Rate (mg/d)

Appendix A
Noncancer Hazard Quotient by Chemical And Pathway for All Receptors

Dermal Contact with Soil and/or Sediment containing Arsenic

Exposure Areas and Receptors	Matrix	Arsenic Concentration (C) mg/kg	Intake Factor (IF)	Dermal Absorption (A)	Daily Intake DI = CxIFxA (mg/kg-day)	Reference Dose (RfD) (mg/kg-day)	Hazard Quotient HQ=DI÷RfD
Onsite Construction Worker 1	Soil	123	1.3E-06	3.0E-02	4.8E-06	3.0E-04	1.6E-02
Onsite Construction Worker 2	Soil	123	6.5E-06	3.0E-02	2.4E-05	3.0E-04	7.9E-02
Onsite Utility Worker	Soil	123	2.6E-07	3.0E-02	9.5E-07	3.0E-04	3.2E-03
Grassy Area Groundskeeper	Soil and Sediment	779	1.3E-06	3.0E-02	3.0E-05	3.0E-04	1.0E-01
Grassy Area Future Industrial Site Worker	Soil and Sediment	779	1.3E-06	3.0E-02	3.0E-05	3.0E-04	1.0E-01
Grassy Area Construction Worker 1	Soil and Sediment	818	1.3E-06	3.0E-02	3.2E-05	3.0E-04	1.1E-01
Grassy Area Construction Worker 2	Soil and Sediment	818	6.5E-06	3.0E-02	1.6E-04	3.0E-04	5.3E-01
Grassy Area Adolescent Trespasser	Soil	60	3.0E-07	3.0E-02	5.3E-07	3.0E-04	1.8E-03
Grassy Area Adolescent Trespasser	Sediment	1387	3.0E-07	3.0E-02	1.2E-05	3.0E-04	4.1E-02
Arlington Ave Adolescent Recreator	Sediment	38	5.9E-07	3.0E-02	6.8E-07	3.0E-04	2.3E-03
Railroad Ditches Adolescent Recreator	Sediment	169	5.9E-07	3.0E-02	3.0E-06	3.0E-04	1.0E-02
Offsite Gas Facility Worker	Soil	29	5.8E-06	3.0E-02	5.0E-06	3.0E-04	1.7E-02

Notes:

IF = Intake Factor (AF * SA * EF * ED * CF) / (BW * AT) =
AT = Averaging Time - Noncancer (d) = ED * EF
BW = Body Weight (kg)
CF = Conversion Factor (kg/mg)
ED = Exposure Duration (yrs)
EF = Exposure Frequency (d/yr)
SA = Surface Area Exposed to Soil and/or Sediment (cm^2/event)
AF = Soil and/or Sediment/Skin Adherence Factor (mg/cm^2)

Appendix B
Data Sets Used for Lead EPCs
and
Lead Cleanup Calculations

Onsite Lead Data
Averaged by Location

Average of All:	20266

Exposure Area	Station	Year	Number of Samples	Average (mg/kg)
Site	CSB1	1999	3	135837
Site	CSB1	2001	6	41830
Site	CSB-10	1999	4	92512
Site	CSB-10	2001	6	170374
Site	CSB11	1999	3	151841
Site	CSB12	1999	3	279784
Site	CSB13	1999	3	134
Site	CSB13	2001	5	702
Site	CSB14	1999	3	19
Site	CSB15	1999	3	42
Site	CSB16	1999	3	213
Site	CSB17	1999	3	69
Site	CSB18	1999	3	45
Site	CSB19	1999	3	132
Site	CSB2	1999	3	137800
Site	CSB20	1999	3	24
Site	CSB21	1999	3	131
Site	CSB22	1999	3	9
Site	CSB23	1999	3	18
Site	CSB24	1999	3	20
Site	CSB25	1999	3	980
Site	CSB26	1999	3	282
Site	CSB-26	2001	5	70
Site	CSB27	1999	3	16
Site	CSB28	1999	3	21
Site	CSB28	2001	5	20
Site	CSB29	1999	3	37
Site	CSB3	1999	5	88646
Site	CSB30	1999	3	15
Site	CSB30	2001	5	603
Site	CSB31	1999	3	907
Site	CSB32	1999	3	14632
Site	CSB32	2001	5	63632
Site	CSB33	1999	3	436
Site	CSB34	1999	3	32309
Site	CSB35	1999	6	3955
Site	CSB35	2001	6	70255
Site	CSB36	1999	3	82
Site	CSB37	1999	3	294
Site	CSB38	1999	3	19
Site	CSB38	2001	5	1313
Site	CSB39	1999	3	15628
Site	CSB4	1999	3	217355
Site	CSB40	1999	3	2231
Site	CSB41	1999	3	21
Site	CSB42	1999	3	12
Site	CSB49	1999	3	61
Site	CSB5	1999	3	78
Site	CSB50	1999	3	280
Site	CSB51	1999	6	17000
Site	CSB6	1999	3	95
Site	CSB7	1999	5	97267
Site	CSB8	1999	3	28356
Site	CSB9	1999	3	158

Onsite Lead Data
Averaged by Location

Average of All:	20266

Exposure Area	Station	Year	Number of Samples	Average (mg/kg)
Site	RSB12	1999	2	14300
Site	RSB14	1999	2	8290
Site	RSB15	1999	2	641
Site	RSB17	1999	2	276
Site	RSB18	1999	2	288
Site	RSB19	1999	2	12
Site	RSB20	1999	2	345
Site	RSB22	1999	2	358
Site	RSB23	1999	2	572
Site	RSB25	1999	2	45715
Site	RSB26	1999	2	8900
Site	RSB27	1999	2	14
Site	RSB28	1999	2	1809
Site	RSB29	1999	2	915
Site	RSB31	1999	2	25550
Site	RSB32	1999	2	686
Site	RSB33	1999	2	1111
Site	RSB34	1999	2	19
Site	RSB37	1999	2	637
Site	RSB38	1999	2	1220
Site	RSB52	1999	3	56
Site	RSB53	1999	3	19
Site	RSB54	1999	3	13417
Site	RSB55	1999	3	22500
Site	RSB56	1999	3	48
Site	RSB57	1999	3	12750
Site	RSB58	1999	3	21367
Site	RSB71	1999	1	66800
Site	RSB72	1999	3	21
Site	RSB73	1999	3	2344
Site	RSB74	1999	3	211
Site	RSB75	1999	3	1894
Site	RSB76	1999	3	242
Site	RSB77	1999	3	4617
Site	RSB78	1999	3	2873
Site	RSB79	1999	3	142
Site	RSB80	1999	3	44
Site	RSB81	1999	3	86
Site	RSB82	1999	3	23
Site	RSB83	1999	3	20
Site	RSB84	1999	3	16
Site	RSB85	1999	3	9
Site	RSED6	1999	2	36000

Onsite Main Facility Area
Individual Sample Data

Construction Worker 1	
PRG	4600
RAL	78900

Construction Worker 2	
PRG	920
RAL	8470

MATRIX	Station	SAMPLE ID	DEPTH	Arsenic	Lead
SOIL	CSB-10	CSB-10A-D	24-27"	2730	475000
SOIL	CSB12	CSB12A	0-3"	1050	467000
SOIL	CSB4	CSB4B	6-9"	164	460000
SOIL	CSB12	CSB12B	6-9"	2270	372000
SOIL	CSB11	CSB11B	6-9"	585	351000
SOIL	CSB35	CSB-35A-C	12-15"	408	350000
SOIL	CSB-10	CSB-10A-F	48-51"	1700	288000
SOIL	CSB1	CSB1B	6-9"	599	268000
SOIL	CSB-10	CSB-10A-C	12-15"	433	256000
SOIL	CSB7	CSB7A	0-3"	81	255000
SOIL	CSB1	CSB-1A-D	24-27"	989	249000
SOIL	CSB-10	CSB10B	6-9"	916	236000
SOIL	CSB4	CSB4A	0-3"	690	192000
SOIL	CSB2	CSB2C	12-15"	469	180000
SOIL	CSB2	CSB2A	0-3"	266	175000
SOIL	CSB32	CSB-32A-A	0-3"	394	164000
SOIL	CSB7	CSB7B	6-9"	788	154000
SOIL	CSB3	CSB3B	6-9"	565	150000
SOIL	CSB1	CSB1A	0-3"	406	139000
SOIL	CSB-10	CSB10A	0-3"	709	132000
SOIL	CSB3	CSB3A	0-3"	284	121000
SOIL	CSB11	CSB11A	0-3"	237	104000
SOIL	CSB34	CSB34A	0-3"	189	94500
SOIL	CSB3	CSB3D	24-28"	193	93900
SOIL	CSB32	CSB-32A-B	6-9"	199	90100
SOIL	CSB8	CSB8A	0-3"	66	83800
SOIL	RSB25	RSB25A	0-3"	867	83500
SOIL	CSB3	CSB3C	12-15"	217	78100
SOIL	CSB7	CSB7C	12-15"	343	77200
SOIL	CSB35	CSB-35A-A	0-3"	154	70400
SOIL	RSB71	RSB71A	0-3"	215	66800
SOIL	CSB32	CSB-32A-C	12-15"	230	64000
SOIL	CSB2	CSB2B	6-9"	159	58400
SED	RSED6	RSED6A	0-6"	305	57200
SOIL	CSB51	CSB51A	0-3"	265	47300
SOIL	CSB39	CSB39A	0-3"	863	46800
SOIL	CSB32	CSB32A	0-3"	388	42800
SOIL	RSB58	RSB58A	0-3"	247	32000
SOIL	RSB31	RSB31B	3-10"	232	27400
SOIL	RSB55	RSB55A	0-3"	323	27400
SOIL	RSB55	RSB55B	3-10"	359	27000
SOIL	RSB31	RSB31A	0-3"	202	23700
SOIL	RSB54	RSB54A	0-3"	107	22800
SOIL	RSB58	RSB58B	3-10"	200	21000
SOIL	CSB51	CSB51D	24-28"	36	18700
SOIL	RSB12	RSB12B	3-10"	125	17500
SOIL	RSB57	RSB57B	3-10"	127	17400
SOIL	RSB54	RSB54B	3-10"	94	17300

Average	23744	3803
SAMPLE ID	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
SAMPLE ID	475000	50
CSB-10A-D	467000	50
CSB12A	460000	50
CSB4B	372000	50
CSB12B	351000	50
CSB11B	350000	50
CSB-35A-C	288000	50
CSB-10A-F	268000	50
CSB1B	256000	50
CSB-10A-C	255000	50
CSB7A	249000	50
CSB-1A-D	236000	50
CSB10B	192000	50
CSB4A	180000	50
CSB2C	175000	50
CSB2A	164000	50
CSB-32A-A	154000	50
CSB7B	150000	50
CSB3B	139000	50
CSB1A	132000	50
CSB10A	121000	50
CSB3A	104000	50
CSB11A	94500	50
CSB34A	93900	50
CSB3D	90100	50
CSB-32A-B	83800	50
CSB8A	83500	50
RSB25A	78100	78100
CSB3C	77200	77200
CSB7C	70400	70400
CSB-35A-A	66800	66800
RSB71A	64000	64000
CSB-32A-C	58400	58400
CSB2B	57200	57200
RSED6A	47300	47300
CSB51A	46800	46800
CSB39A	42800	42800
CSB32A	32000	32000
RSB58A	27400	27400
RSB31B	27400	27400
RSB55A	27000	27000
RSB55B	23700	23700
RSB31A	22800	22800
RSB54A	21000	21000
RSB58B	18700	18700
CSB51D	17500	17500
RSB12B	17400	17400
RSB57B	17300	17300

Average	23744	507
SAMPLE ID	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
SAMPLE ID	475000	50
CSB-10A-D	467000	50
CSB12A	460000	50
CSB4B	372000	50
CSB12B	351000	50
CSB11B	350000	50
CSB-35A-C	288000	50
CSB-10A-F	268000	50
CSB1B	256000	50
CSB-10A-C	255000	50
CSB7A	249000	50
CSB-1A-D	236000	50
CSB10B	192000	50
CSB4A	180000	50
CSB2C	175000	50
CSB2A	164000	50
CSB-32A-A	154000	50
CSB7B	150000	50
CSB3B	139000	50
CSB1A	132000	50
CSB10A	121000	50
CSB3A	104000	50
CSB11A	94500	50
CSB34A	93900	50
CSB3D	90100	50
CSB-32A-B	83800	50
CSB8A	83500	50
RSB25A	78100	50
CSB3C	77200	50
CSB7C	70400	50
CSB-35A-A	66800	50
RSB71A	64000	50
CSB-32A-C	58400	50
CSB2B	57200	50
RSED6A	47300	50
CSB51A	46800	50
CSB39A	42800	50
CSB32A	32000	50
RSB58A	27400	50
RSB31B	27400	50
RSB55A	27000	50
RSB55B	23700	50
RSB31A	22800	50
RSB54A	21000	50
RSB58B	18700	50
CSB51D	17500	50
RSB12B	17400	50
RSB57B	17300	50

Onsite Main Facility Area
Individual Sample Data

MATRIX	Station	SAMPLE ID	DEPTH	Arsenic	Lead
SOIL	RSB57	RSB57A	0-3"	235	17000
SED	RSED6	RSED6B	6-12"	114	14800
SOIL	RSB55	RSB55C	24-30"	60	13100
SOIL	CSB51	CSB51E	36-39"	26	12000
SOIL	RSB12	RSB12A	0-3"	95	11100
SOIL	RSB58	RSB58C	24-30"	37	11100
SOIL	CSB35	CSB35D	24-28"	12	10800
SOIL	RSB77	RSB77A	0-3"	7	10700
SOIL	CSB51	CSB51B	6-9"	187	10300
SOIL	RSB26	RSB26A	0-3"	175	9670
SOIL	RSB14	RSB14B	3-10"	15	8480
SOIL	RSB26	RSB26B	3-10"	184	8130
SOIL	RSB14	RSB14A	0-3"	24	8100
SOIL	CSB51	CSB51F	48-51"	18	8020
SOIL	RSB25	RSB25B	3-10"	104	7930
SOIL	RSB73	RSB73A	0-3"	18	6710
SOIL	CSB40	CSB40A	0-3"	39	6660
SOIL	CSB38	CSB-38A-A	0-3"	67	6200
SOIL	CSB51	CSB51C	12-15"	17	5680
SOIL	CSB35	CSB35E	36-39"	15	4910
SOIL	RSB57	RSB57C	24-30"	16	3850
SOIL	RSB75	RSB75A	0-3"	58	3220
SOIL	RSB28	RSB28A	0-3"	56	3140
SOIL	CSB35	CSB35A	0-3"	8.4	3090
SOIL	RSB78	RSB78A	0-3"	14	3060
SOIL	CSB35	CSB35F	48-51"	12	3010
SOIL	RSB78	RSB78C	24-30"	13	2960
SOIL	RSB77	RSB77B	3-10"	7.7	2920
SOIL	RSB78	RSB78B	3-10"	12	2600
SOIL	CSB25	CSB25B	6-9"	75	2420
SOIL	CSB30	CSB-30A-A	0-3"	30	2360
SOIL	CSB34	CSB34B	6-9"	9.1	2360
SOIL	CSB13	CSB-13A-A	0-3"	11	2300
SOIL	CSB31	CSB31B	6-9"	22	2280
SOIL	RSB33	RSB33A	0-3"	56	2200
SOIL	RSB38	RSB38A	0-3"	14	2000
SOIL	CSB-10	CSB-10A-A	0-3"	4.5	1780
SOIL	CSB-10	CSB10C	12-15"	17	1500
SOIL	RSB75	RSB75B	3-10"	15	1500
SOIL	RSB29	RSB29A	0-3"	23	1480
SOIL	CSB35	CSB35C	12-15"	7	1400
SOIL	CSB-10	CSB-10A-B	6-9"	6.1	1210
SOIL	CSB13	CSB-13A-B	6-9"	22	1070
SOIL	RSB15	RSB15A	0-3"	22	1070
SOIL	CSB8	CSB8B	6-9"	10	989
SOIL	RSB23	RSB23A	0-3"	18	987
SOIL	RSB75	RSB75C	24-30"	12	962
SOIL	CSB1	CSB-1A-A	0-3"	3.2	903

Construction Worker 1	
PRG	4600
RAL	78900

Average	23744	3803
SAMPLE ID	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
RSB54B	17000	17000
RSB57A	14800	14800
RSED6B	13100	13100
RSB55C	12000	12000
CSB51E	11100	11100
RSB12A	11100	11100
RSB58C	10800	10800
CSB35D	10700	10700
RSB77A	10300	10300
CSB51B	9670	9670
RSB26A	8480	8480
RSB14B	8130	8130
RSB26B	8100	8100
RSB14A	8020	8020
CSB51F	7930	7930
RSB25B	6710	6710
RSB73A	6660	6660
CSB40A	6200	6200
CSB-38A-A	5680	5680
CSB51C	4910	4910
CSB35E	3850	3850
RSB57C	3220	3220
RSB75A	3140	3140
RSB28A	3090	3090
CSB35A	3060	3060
RSB78A	3010	3010
CSB35F	2960	2960
RSB78C	2920	2920
RSB77B	2600	2600
RSB78B	2420	2420
CSB25B	2360	2360
CSB-30A-A	2360	2360
CSB34B	2300	2300
CSB-13A-A	2280	2280
CSB31B	2200	2200
RSB33A	2000	2000
RSB38A	1780	1780
CSB-10A-A	1500	1500
CSB10C	1500	1500
RSB75B	1480	1480
RSB29A	1400	1400
CSB35C	1210	1210
CSB-10A-B	1070	1070
CSB-13A-B	1070	1070
RSB15A	989	989
CSB8B	987	987
RSB23A	962	962
RSB75C	903	903

Construction Worker 2	
PRG	920
RAL	8470

Average	23744	507
SAMPLE ID	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
RSB54B	17000	50
RSB57A	14800	50
RSED6B	13100	50
RSB55C	12000	50
CSB51E	11100	50
RSB12A	11100	50
RSB58C	10800	50
CSB35D	10700	50
RSB77A	10300	50
CSB51B	9670	50
RSB26A	8480	50
RSB14B	8130	8130
RSB26B	8100	8100
RSB14A	8020	8020
CSB51F	7930	7930
RSB25B	6710	6710
RSB73A	6660	6660
CSB40A	6200	6200
CSB-38A-A	5680	5680
CSB51C	4910	4910
CSB35E	3850	3850
RSB57C	3220	3220
RSB75A	3140	3140
RSB28A	3090	3090
CSB35A	3060	3060
RSB78A	3010	3010
CSB35F	2960	2960
RSB78C	2920	2920
RSB77B	2600	2600
RSB78B	2420	2420
CSB25B	2360	2360
CSB-30A-A	2360	2360
CSB34B	2300	2300
CSB-13A-A	2280	2280
CSB31B	2200	2200
RSB33A	2000	2000
RSB38A	1780	1780
CSB-10A-A	1500	1500
CSB10C	1500	1500
RSB75B	1480	1480
RSB29A	1400	1400
CSB35C	1210	1210
CSB-10A-B	1070	1070
CSB-13A-B	1070	1070
RSB15A	989	989
CSB8B	987	987
RSB23A	962	962
RSB75C	903	903

Onsite Main Facility Area
Individual Sample Data

Construction Worker 1	
PRG	4600
RAL	78900

Construction Worker 2	
PRG	920
RAL	8470

MATRIX	Station	SAMPLE ID	DEPTH	Arsenic	Lead
SOIL	CSB33	CSB33B	6-9"	12	868
SOIL	CSB1	CSB-1A-E	36-39"	6.8	847
SOIL	RSB32	RSB32A	0-3"	13	841
SOIL	CSB32	CSB32C	12-15"	7	694
SOIL	RSB37	RSB37A	0-3"	17	679
SOIL	RSB76	RSB76B	3-10"	10	648
SOIL	RSB37	RSB37B	3-10"	13	594
SOIL	RSB20	RSB20A	0-3"	14	593
SOIL	CSB26	CSB26C	12-15"	8.6	583
SOIL	CSB-10	CSB10D	12-15"	6.9	548
SOIL	RSB32	RSB32B	3-10"	7.7	531
SOIL	RSB17	RSB17A	0-3"	10	530
SOIL	RSB18	RSB18A	0-3"	7.8	526
SOIL	CSB11	CSB11C	12-15"	14	522
SOIL	CSB35	CSB35B	6-9"	9.5	518
SOIL	CSB1	CSB1C	12-15"	8	511
SOIL	CSB35	CSB-35A-E	36-39"	6.3	499
SOIL	CSB50	CSB50A	0-3"	15	480
SOIL	RSB22	RSB22A	0-3"	21	478
SOIL	RSB28	RSB28B	3-10"	16	478
SOIL	RSB38	RSB38B	3-10"	7.2	440
SOIL	CSB31	CSB31A	0-3"	14	431
SOIL	CSB25	CSB25A	0-3"	13	411
SOIL	CSB32	CSB32B	6-9"	7.4	403
SOIL	RSB74	RSB74A	0-3"	13	380
SOIL	CSB30	CSB-30A-B	6-9"	13	366
SOIL	CSB12	CSB12C	12-15"	14	353
SOIL	RSB29	RSB29B	3-10"	11	350
SOIL	CSB21	CSB21B	6-9"	9.3	329
SOIL	CSB37	CSB37A	0-3"	30	325
SOIL	CSB13	CSB13A	0-3"	38	323
SOIL	CSB38	CSB-38A-E	36-39"	8.6	319
SOIL	CSB37	CSB37B	6-9"	7.9	314
SOIL	CSB9	CSB9A	0-3"	12	289
SOIL	CSB35	CSB-35A-D	24-27"	6	285
SOIL	CSB35	CSB-35A-B	6-9"	6.1	279
SOIL	CSB8	CSB8C	12-15"	10	279
SOIL	CSB-10	CSB-10A-E	36-39"	7.1	253
SOIL	CSB33	CSB33C	12-15"	13	245
SOIL	CSB30	CSB-30A-C	12-15"	9.1	243
SOIL	CSB37	CSB37C	12-15"	6.8	242
SOIL	RSB22	RSB22B	3-10"	10	237
SOIL	CSB16	CSB16C	12-15"	7.5	234
SOIL	CSB3	CSB3E	36-39"	12	232
SOIL	RSB77	RSB77C	24-30"	6.6	232
SOIL	CSB50	CSB50C	12-15"	10	229
SOIL	RSB81	RSB81A	0-3"	9.4	229
SOIL	RSB15	RSB15B	3-10"	10	211

Average	23744	3803
SAMPLE ID	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
CSB-1A-A	868	868
CSB33B	847	847
CSB-1A-E	841	841
RSB32A	694	694
CSB32C	679	679
RSB37A	648	648
RSB76B	594	594
RSB37B	593	593
RSB20A	583	583
CSB26C	548	548
CSB10D	531	531
RSB32B	530	530
RSB17A	526	526
RSB18A	522	522
CSB11C	518	518
CSB35B	511	511
CSB1C	499	499
CSB-35A-E	480	480
CSB50A	478	478
RSB22A	478	478
RSB28B	440	440
RSB38B	431	431
CSB31A	411	411
CSB25A	403	403
CSB32B	380	380
RSB74A	366	366
CSB-30A-B	353	353
CSB12C	350	350
RSB29B	329	329
CSB21B	325	325
CSB37A	323	323
CSB13A	319	319
CSB-38A-E	314	314
CSB37B	289	289
CSB9A	285	285
CSB-35A-D	279	279
CSB-35A-B	279	279
CSB8C	253	253
CSB-10A-E	245	245
CSB33C	243	243
CSB-30A-C	242	242
CSB37C	237	237
RSB22B	234	234
CSB16C	232	232
CSB3E	232	232
RSB77C	229	229
CSB50C	229	229
RSB81A	211	211

Average	23744	507
SAMPLE ID	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
CSB-1A-A	868	868
CSB33B	847	847
CSB-1A-E	841	841
RSB32A	694	694
CSB32C	679	679
RSB37A	648	648
RSB76B	594	594
RSB37B	593	593
RSB20A	583	583
CSB26C	548	548
CSB10D	531	531
RSB32B	530	530
RSB17A	526	526
RSB18A	522	522
CSB11C	518	518
CSB35B	511	511
CSB1C	499	499
CSB-35A-E	480	480
CSB50A	478	478
RSB22A	478	478
RSB28B	440	440
RSB38B	431	431
CSB31A	411	411
CSB25A	403	403
CSB32B	380	380
RSB74A	366	366
CSB-30A-B	353	353
CSB12C	350	350
RSB29B	329	329
CSB21B	325	325
CSB37A	323	323
CSB13A	319	319
CSB-38A-E	314	314
CSB37B	289	289
CSB9A	285	285
CSB-35A-D	279	279
CSB-35A-B	279	279
CSB8C	253	253
CSB-10A-E	245	245
CSB33C	243	243
CSB-30A-C	242	242
CSB37C	237	237
RSB22B	234	234
CSB16C	232	232
CSB3E	232	232
RSB77C	229	229
CSB50C	229	229
RSB81A	211	211

Onsite Main Facility Area
Individual Sample Data

MATRIX	Station	SAMPLE ID	DEPTH	Arsenic	Lead
SOIL	CSB16	CSB16A	0-3"	6	209
SOIL	RSB79	RSB79B	3-10"	6.9	205
SOIL	CSB33	CSB33A	0-3"	13	196
SOIL	CSB16	CSB16B	6-9"	7.2	195
SOIL	CSB26	CSB26A	0-3"	7.7	191
SOIL	CSB19	CSB19A	0-3"	9	187
SOIL	RSB73	RSB73C	24-30"	7.6	178
SOIL	RSB74	RSB74B	3-10"	9	177
SOIL	CSB-26	CSB-26A-A	0-3"	12	174
SOIL	CSB1	CSB-1A-F	48-51"	8.5	170
SOIL	CSB6	CSB6A	0-3"	8.9	165
SOIL	RSB79	RSB79C	24-30"	8.1	164
SOIL	RSB23	RSB23B	3-10"	2.6	157
SOIL	RSB54	RSB54C	24-30"	3.4	151
SOIL	CSB49	CSB49A	0-3"	8.1	147
SOIL	RSB73	RSB73B	3-10"	11	145
SOIL	CSB9	CSB9B	6-9"	11	132
SOIL	CSB50	CSB50B	6-9"	13	131
SOIL	CSB19	CSB19C	12-15"	6.7	129
SOIL	CSB5	CSB5A	0-3"	7.2	125
SOIL	CSB7	CSB7D	24-28"	6.9	114
SOIL	CSB25	CSB25C	12-15"	8.8	108
SOIL	CSB36	CSB36A	0-3"	170	103
SOIL	CSB17	CSB17C	12-15"	6.9	101
SOIL	RSB20	RSB20B	3-10"	10	97
SOIL	CSB15	CSB15B	6-9"	7.8	89
SOIL	CSB-26	CSB-26A-B	6-9"	11	88
SOIL	RSB56	RSB56C	24-30"	6.1	88
SOIL	CSB17	CSB17A	0-3"	7.3	87
SOIL	RSB80	RSB80A	0-3"	7.4	85
SOIL	CSB19	CSB19B	6-9"	6.8	79
SOIL	RSB52	RSB52B	3-10"	5.9	77
SOIL	CSB36	CSB36B	6-9"	15	76
SOIL	CSB13	CSB-13A-C	12-15"	6.6	75
SOIL	RSB74	RSB74C	24-30"	4.9	75
SOIL	CSB26	CSB26B	6-9"	6.5	73
SOIL	RSB76	RSB76C	24-30"	7.7	72
SOIL	CSB18	CSB18A	0-3"	7.8	70
SOIL	CSB35	CSB-35A-F	48-51"	6.3	69
SOIL	CSB39	CSB39B	6-9"	8	69
SOIL	CSB6	CSB6C	12-15"	11	69
SOIL	CSB34	CSB34C	12-15"	7	68
SOIL	CSB36	CSB36C	12-15"	12	67
SOIL	CSB5	CSB5B	6-9"	7.1	67
SOIL	RSB52	RSB52C	24-30"	6.9	67
SOIL	CSB4	CSB4C	12-15"	6.8	65
SOIL	RSB79	RSB79A	0-3"	8.5	57
SOIL	CSB9	CSB9C	12-15"	7.7	53

Construction Worker 1	
PRG	4600
RAL	78900

Average	23744	3803
SAMPLE ID	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
RSB15B	209	209
CSB16A	205	205
RSB79B	196	196
CSB33A	195	195
CSB16B	191	191
CSB26A	187	187
CSB19A	178	178
RSB73C	177	177
RSB74B	174	174
CSB-26A-A	170	170
CSB-1A-F	165	165
CSB6A	164	164
RSB79C	157	157
RSB23B	151	151
RSB54C	147	147
CSB49A	145	145
RSB73B	132	132
CSB9B	131	131
CSB50B	129	129
CSB19C	125	125
CSB5A	114	114
CSB7D	108	108
CSB25C	103	103
CSB36A	101	101
CSB17C	97	97
RSB20B	89	89
CSB15B	88	88
CSB-26A-B	88	88
RSB56C	87	87
CSB17A	85	85
RSB80A	79	79
CSB19B	77	77
RSB52B	76	76
CSB36B	75	75
CSB-13A-C	75	75
RSB74C	73	73
CSB26B	72	72
RSB76C	70	70
CSB18A	69	69
CSB-35A-F	69	69
CSB39B	69	69
CSB6C	68	68
CSB34C	67	67
CSB36C	67	67
CSB5B	67	67
RSB52C	65	65
CSB4C	57	57
RSB79A	53	53

Construction Worker 2	
PRG	920
RAL	8470

Average	23744	507
SAMPLE ID	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
RSB15B	209	209
CSB16A	205	205
RSB79B	196	196
CSB33A	195	195
CSB16B	191	191
CSB26A	187	187
CSB19A	178	178
RSB73C	177	177
RSB74B	174	174
CSB-26A-A	170	170
CSB-1A-F	165	165
CSB6A	164	164
RSB79C	157	157
RSB23B	151	151
RSB54C	147	147
CSB49A	145	145
RSB73B	132	132
CSB9B	131	131
CSB50B	129	129
CSB19C	125	125
CSB5A	114	114
CSB7D	108	108
CSB25C	103	103
CSB36A	101	101
CSB17C	97	97
RSB20B	89	89
CSB15B	88	88
CSB-26A-B	88	88
RSB56C	87	87
CSB17A	85	85
RSB80A	79	79
CSB19B	77	77
RSB52B	76	76
CSB36B	75	75
CSB-13A-C	75	75
RSB74C	73	73
CSB26B	72	72
RSB76C	70	70
CSB18A	69	69
CSB-35A-F	69	69
CSB39B	69	69
CSB6C	68	68
CSB34C	67	67
CSB36C	67	67
CSB5B	67	67
RSB52C	65	65
CSB4C	57	57
RSB79A	53	53

Onsite Main Facility Area
Individual Sample Data

Construction Worker 1	
PRG	4600
RAL	78900

Construction Worker 2	
PRG	920
RAL	8470

MATRIX	Station	SAMPLE ID	DEPTH	Arsenic	Lead
SOIL	CSB6	CSB6B	6-9"	9.6	50
SOIL	RSB18	RSB18B	3-10"	6.3	50
SOIL	CSB13	CSB13C	12-15"	10	49
SOIL	CSB41	CSB41A	0-3"	4.8	45
SOIL	CSB1	CSB-1A-C	12-15"	1.5	44
SOIL	CSB29	CSB29B	6-9"	25	44
SOIL	CSB5	CSB5C	12-15"	5.1	42
SOIL	CSB-26	CSB-26A-C	12-15"	6.4	40
SOIL	CSB32	CSB-32A-D	24-27"	8	40
SOIL	CSB13	CSB-13A-D	24-27"	5.9	39
SOIL	CSB18	CSB18C	12-15"	8.3	38
SOIL	RSB82	RSB82B	3-10"	24	37
SOIL	CSB29	CSB29C	12-15"	11	36
SOIL	RSB72	RSB72A	0-3"	8.7	34
SOIL	CSB21	CSB21C	12-15"	6.8	32
SOIL	CSB23	CSB23C	12-15"	6.2	32
SOIL	CSB29	CSB29A	0-3"	9.2	32
SOIL	CSB30	CSB-30A-D	24-27"	6.6	32
SOIL	CSB21	CSB21A	0-3"	7.8	31
SOIL	RSB83	RSB83C	24-30"	16	31
SOIL	CSB13	CSB13B	6-9"	11	30
SOIL	CSB20	CSB20A	0-3"	9.6	30
SOIL	CSB28	CSB-28A-A	0-3"	53	30
SOIL	RSB56	RSB56A	0-3"	8.6	30
SOIL	CSB28	CSB28C	12-15"	23	29
SOIL	CSB14	CSB14A	0-3"	2.2	28
SOIL	CSB15	CSB15C	12-15"	5.3	28
SOIL	CSB24	CSB24A	0-3"	4.8	28
SOIL	CSB13	CSB-13A-E	36-39"	6	27
SOIL	CSB28	CSB-28A-C	12-15"	7.9	27
SOIL	RSB56	RSB56B	3-10"	7.7	27
SOIL	CSB18	CSB18B	6-9"	6	26
SOIL	CSB-26	CSB-26A-D	24-27"	6.2	25
SOIL	RSB52	RSB52A	0-3"	6.6	25
SOIL	CSB20	CSB20C	12-15"	2.4	23
SOIL	CSB-26	CSB-26A-E	36-39"	5.8	23
SOIL	RSB80	RSB80B	3-10"	7	23
SOIL	RSB80	RSB80C	24-30"	6.7	23
SOIL	CSB27	CSB27A	0-3"	6.3	22
SOIL	CSB38	CSB38A	0-3"	4.9	22
SOIL	CSB38	CSB-38A-C	12-15"	9.3	22
SOIL	RSB33	RSB33B	3-10"	10	22
SOIL	RSB17	RSB17B	3-10"	9.7	21
SOIL	RSB53	RSB53A	0-3"	8.2	21
SOIL	RSB84	RSB84B	3-10"	15	21
SOIL	CSB17	CSB17B	6-9"	7.1	20
SOIL	CSB24	CSB24B	6-9"	9.3	20
SOIL	CSB32	CSB-32A-E	36-39"	6.5	20

Average	23744	3803
SAMPLE ID	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
CSB9C	50	50
CSB6B	50	50
RSB18B	49	49
CSB13C	45	45
CSB41A	44	44
CSB-1A-C	44	44
CSB29B	42	42
CSB5C	40	40
CSB-26A-C	40	40
CSB-32A-D	39	39
CSB-13A-D	38	38
CSB18C	37	37
RSB82B	36	36
CSB29C	34	34
RSB72A	32	32
CSB21C	32	32
CSB23C	32	32
CSB29A	32	32
CSB-30A-D	31	31
CSB21A	31	31
RSB83C	30	30
CSB13B	30	30
CSB20A	30	30
CSB-28A-A	30	30
RSB56A	29	29
CSB28C	28	28
CSB14A	28	28
CSB15C	28	28
CSB24A	27	27
CSB-13A-E	27	27
CSB-28A-C	27	27
RSB56B	26	26
CSB18B	25	25
CSB-26A-D	25	25
RSB52A	23	23
CSB20C	23	23
CSB-26A-E	23	23
RSB80B	23	23
RSB80C	22	22
CSB27A	22	22
CSB38A	22	22
CSB-38A-C	22	22
RSB33B	21	21
RSB17B	21	21
RSB53A	21	21
RSB84B	20	20
CSB17B	20	20
CSB24B	20	20

Average	23744	507
SAMPLE ID	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
CSB9C	50	50
CSB6B	50	50
RSB18B	49	49
CSB13C	45	45
CSB41A	44	44
CSB-1A-C	44	44
CSB29B	42	42
CSB5C	40	40
CSB-26A-C	40	40
CSB-32A-D	39	39
CSB-13A-D	38	38
CSB18C	37	37
RSB82B	36	36
CSB29C	34	34
RSB72A	32	32
CSB21C	32	32
CSB23C	32	32
CSB29A	32	32
CSB-30A-D	31	31
CSB21A	31	31
RSB83C	30	30
CSB13B	30	30
CSB20A	30	30
CSB-28A-A	30	30
RSB56A	29	29
CSB28C	28	28
CSB14A	28	28
CSB15C	28	28
CSB24A	27	27
CSB-13A-E	27	27
CSB-28A-C	27	27
RSB56B	26	26
CSB18B	25	25
CSB-26A-D	25	25
RSB52A	23	23
CSB20C	23	23
CSB-26A-E	23	23
RSB80B	23	23
RSB80C	22	22
CSB27A	22	22
CSB38A	22	22
CSB-38A-C	22	22
RSB33B	21	21
RSB17B	21	21
RSB53A	21	21
RSB84B	20	20
CSB17B	20	20
CSB24B	20	20

Onsite Main Facility Area
Individual Sample Data

Construction Worker 1	
PRG	4600
RAL	78900

Construction Worker 2	
PRG	920
RAL	8470

MATRIX	Station	SAMPLE ID	DEPTH	Arsenic	Lead
SOIL	CSB40	CSB40B	6-9"	6.4	20
SOIL	CSB20	CSB20B	6-9"	6.9	19
SOIL	CSB28	CSB28B	6-9"	10	19
SOIL	CSB38	CSB38C	12-15"	7.8	19
SOIL	CSB7	CSB7E	36-39"	6.2	19
SOIL	RSB34	RSB34A	0-3"	6.5	19
SOIL	RSB34	RSB34B	3-10"	6.3	19
SOIL	CSB1	CSB-1A-B	6-9"	1.5	18
SOIL	CSB14	CSB14C	12-15"	6.4	18
SOIL	CSB49	CSB49B	6-9"	6.4	18
SOIL	RSB53	RSB53B	3-10"	8.3	18
SOIL	RSB81	RSB81B	3-10"	9.3	18
SOIL	CSB49	CSB49C	12-15"	6.8	17
SOIL	RSB53	RSB53C	24-30"	6.9	17
SOIL	RSB83	RSB83A	0-3"	9.9	17
SOIL	CSB28	CSB-28A-E	36-39"	9.4	16
SOIL	CSB30	CSB30A	0-3"	9.5	16
SOIL	RSB82	RSB82A	0-3"	8.5	16
SOIL	RSB82	RSB82C	24-30"	9.3	16
SOIL	RSB84	RSB84A	0-3"	10	16
SOIL	CSB30	CSB30C	12-15"	11	15
SOIL	CSB38	CSB38B	6-9"	4.4	15
SOIL	CSB39	CSB39C	12-15"	5.8	15
SOIL	CSB42	CSB42C	12-15"	7.8	15
SOIL	RSB72	RSB72B	3-10"	7	15
SOIL	RSB72	RSB72C	24-30"	8.2	15
SOIL	CSB27	CSB27C	12-15"	6.4	14
SOIL	CSB28	CSB28A	0-3"	4.4	14
SOIL	CSB28	CSB-28A-D	24-27"	6.5	14
SOIL	CSB38	CSB-38A-B	6-9"	7.9	14
SOIL	CSB40	CSB40C	12-15"	11	14
SOIL	RSB27	RSB27A	0-3"	8.1	14
SOIL	RSB27	RSB27B	3-10"	6.5	14
SOIL	CSB27	CSB27B	6-9"	8.5	13
SOIL	CSB28	CSB-28A-B	6-9"	5.1	13
SOIL	CSB30	CSB-30A-E	36-39"	6.6	13
SOIL	CSB30	CSB30B	6-9"	6.7	13
SOIL	RSB19	RSB19B	3-10"	6.8	13
SOIL	CSB24	CSB24C	12-15"	4.4	12
SOIL	CSB38	CSB-38A-D	24-27"	2.5	12
SOIL	RSB84	RSB84C	24-30"	5.7	12
SOIL	CSB23	CSB23B	6-9"	7	11
SOIL	CSB42	CSB42A	0-3"	23	11
SOIL	CSB42	CSB42B	6-9"	73	11
SOIL	RSB19	RSB19A	0-3"	7	11
SOIL	RSB81	RSB81C	24-30"	7	11
SOIL	RSB83	RSB83B	3-10"	7.4	11
SOIL	CSB23	CSB23A	0-3"	7.5	10

Average	23744	3803
SAMPLE ID	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
CSB-32A-E	20	20
CSB40B	19	19
CSB20B	19	19
CSB28B	19	19
CSB38C	19	19
CSB7E	19	19
RSB34A	19	19
RSB34B	18	18
CSB-1A-B	18	18
CSB14C	18	18
CSB49B	18	18
RSB53B	18	18
RSB81B	17	17
CSB49C	17	17
RSB53C	17	17
RSB83A	16	16
CSB-28A-E	16	16
CSB30A	16	16
RSB82A	16	16
RSB82C	16	16
RSB84A	15	15
CSB30C	15	15
CSB38B	15	15
CSB39C	15	15
CSB42C	15	15
RSB72B	15	15
RSB72C	14	14
CSB27C	14	14
CSB28A	14	14
CSB-28A-D	14	14
CSB-38A-B	14	14
CSB40C	14	14
RSB27A	14	14
RSB27B	13	13
CSB27B	13	13
CSB-28A-B	13	13
CSB-30A-E	13	13
CSB30B	13	13
RSB19B	12	12
CSB24C	12	12
CSB-38A-D	12	12
RSB84C	11	11
CSB23B	11	11
CSB42A	11	11
CSB42B	11	11
RSB19A	11	11
RSB81C	11	11
RSB83B	10	10

Average	23744	507
SAMPLE ID	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
CSB-32A-E	20	20
CSB40B	19	19
CSB20B	19	19
CSB28B	19	19
CSB38C	19	19
CSB7E	19	19
RSB34A	19	19
RSB34B	18	18
CSB-1A-B	18	18
CSB14C	18	18
CSB49B	18	18
RSB53B	18	18
RSB81B	17	17
CSB49C	17	17
RSB53C	17	17
RSB83A	16	16
CSB-28A-E	16	16
CSB30A	16	16
RSB82A	16	16
RSB82C	16	16
RSB84A	15	15
CSB30C	15	15
CSB38B	15	15
CSB39C	15	15
CSB42C	15	15
RSB72B	15	15
RSB72C	14	14
CSB27C	14	14
CSB28A	14	14
CSB-28A-D	14	14
CSB-38A-B	14	14
CSB40C	14	14
RSB27A	14	14
RSB27B	13	13
CSB27B	13	13
CSB-28A-B	13	13
CSB-30A-E	13	13
CSB30B	13	13
RSB19B	12	12
CSB24C	12	12
CSB-38A-D	12	12
RSB84C	11	11
CSB23B	11	11
CSB42A	11	11
CSB42B	11	11
RSB19A	11	11
RSB81C	11	11
RSB83B	10	10

Onsite Main Facility Area
Individual Sample Data

MATRIX	Station	SAMPLE ID	DEPTH	Arsenic	Lead
SOIL	CSB31	CSB31C	12-15"	6.7	10
SOIL	CSB14	CSB14B	6-9"	5.7	9.8
SOIL	CSB22	CSB22C	12-15"	6.6	9.8
SOIL	CSB15	CSB15A	0-3"	7	9.6
SOIL	RSB85	RSB85A	0-3"	7.1	9.1
SOIL	CSB41	CSB41B	6-9"	7.6	8.9
SOIL	CSB41	CSB41C	12-15"	6.3	8.8
SOIL	RSB85	RSB85C	24-30"	7	8.7
SOIL	RSB85	RSB85B	3-10"	6.7	8.2
SOIL	CSB22	CSB22A	0-3"	6.3	8
SOIL	CSB22	CSB22B	6-9"	6.7	7.7
SOIL	RSB76	RSB76A	0-3"	24	4.7

Construction Worker 1	
PRG	4600
RAL	78900

Average	23744	3803
SAMPLE ID	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
CSB23A	10	10
CSB31C	9.8	9.8
CSB14B	9.8	9.8
CSB22C	9.6	9.6
CSB15A	9.1	9.1
RSB85A	8.9	8.9
CSB41B	8.8	8.8
CSB41C	8.7	8.7
RSB85C	8.2	8.2
RSB85B	8	8
CSB22A	7.7	7.7
CSB22B	4.7	4.7

Construction Worker 2	
PRG	920
RAL	8470

Average	23744	507
SAMPLE ID	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
CSB23A	10	10
CSB31C	9.8	9.8
CSB14B	9.8	9.8
CSB22C	9.6	9.6
CSB15A	9.1	9.1
RSB85A	8.9	8.9
CSB41B	8.8	8.8
CSB41C	8.7	8.7
RSB85C	8.2	8.2
RSB85B	8	8
CSB22A	7.7	7.7
CSB22B	4.7	4.7

Grassy Area Lead Data (0-6 inches)
Soil and Sediment combined

Worker	Lead (ppm)
PRG	3,195
RAL	16,665

MATRIX	Station	DEPTH	Conc. (mg/kg)
SED	RSED4	0-6"	243000
SED	RSED5	0-6"	228000
SED	RSED3	0-6"	95300
SED	RSED2	0-6"	73800
SED	RSED7	0-6"	46000
SED	RSED8	0-6"	34800
SED	RSED9	0-6"	32400
SED	RSED10	0-6"	29300
SED	RSED1	0-6"	19300
SOIL	RSB9	0-3"	14500
SOIL	RSB51	0-3"	12600
SOIL	RSB-70	0-3"	6420
SOIL	RSB50	0-3"	5470
SOIL	RSB4	0-3"	2360
SOIL	RSB24	0-3"	1980
SOIL	RSB6	0-3"	1880
SOIL	RSB10	0-3"	1850
SOIL	BSB2	0-3"	1200
SOIL	RSB7	0-3"	1150
SOIL	RSB43	0-3"	1130
SOIL	RSB2	0-3"	1100
SOIL	BSB4	0-3"	1060
SOIL	RSB49	0-3"	1060
SOIL	RSB8	0-3"	1050
SOIL	RSB5	0-3"	985
SOIL	RSB40	0-3"	901
SOIL	RSB30	0-3"	887
SOIL	RSB1	0-3"	873
SOIL	RSB42	0-3"	834
SOIL	RSB13	0-3"	682
SOIL	RSB16	0-3"	661
SOIL	RSB11	0-3"	641
SOIL	RSB3	0-3"	632
SOIL	RSB21	0-3"	497
SOIL	RSB45	0-3"	487
SOIL	RSB46	0-3"	385
SOIL	RSB44	0-3"	369
SOIL	RSB41	0-3"	341
SOIL	BSB3	0-3"	257
SOIL	RSB39	0-3"	227
SOIL	RSB36	0-3"	216
SOIL	BSB1	0-3"	158
SOIL	RSB35	0-3"	43
		Average Soil and Sediment	20,158
		Average Soil	1908
		Average Sediment	89,100

SAMPLE ID	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
Average	20,158	1,519
RSED4	243000	50
RSED5	228000	50
RSED3	95300	50
RSED2	73800	50
RSED7	46000	50
RSED8	34800	50
RSED9	32400	50
RSED10	29300	50
RSED1	19300	50
RSB9	14500	14500
RSB51	12600	12600
RSB-70	6420	6420
RSB50	5470	5470
RSB4	2360	2360
RSB24	1980	1980
RSB6	1880	1880
RSB10	1850	1850
BSB2	1200	1200
RSB7	1150	1150
RSB43	1130	1130
RSB2	1100	1100
BSB4	1060	1060
RSB49	1060	1060
RSB8	1050	1050
RSB5	985	985
RSB40	901	901
RSB30	887	887
RSB1	873	873
RSB42	834	834
RSB13	682	682
RSB16	661	661
RSB11	641	641
RSB3	632	632
RSB21	497	497
RSB45	487	487
RSB46	385	385
RSB44	369	369
RSB41	341	341
BSB3	257	257
RSB39	227	227
RSB36	216	216
BSB1	158	158
RSB35	43	43

Grassy Area All Depths (0 - 30")
Soil and Sediment combined

Construction Worker 1	Lead (mg/kg)
PRG	4,600
RAL	43,300

Construction Worker 2	Lead (mg/kg)
PRG	920
RAL	4,954

Exposure Area	MATRIX	Station	DEPTH	Lead (mg/kg)
Grassy	SED	RSED4	0-6"	243000
Grassy	SED	RSED5	0-6"	228000
Grassy	SED	RSED5	6-12"	182000
Grassy	SED	RSED3	0-6"	95300
Grassy	SED	RSED2	0-6"	73800
Grassy	SED	RSED7	0-6"	46000
Grassy	SED	RSED8	0-6"	34800
Grassy	SED	RSED9	0-6"	32400
Grassy	SED	RSED1	6-12"	29900
Grassy	SED	RSED10	0-6"	29300
Grassy	SED	RSED8	6-12"	25900
Grassy	SED	RSED7	6-12"	20500
Grassy	SED	RSED1	0-6"	19300
Grassy	SED	RSED4	6-12"	17300
Grassy	SED	RSED10	6-12"	15300
Grassy	SED	RSED9	6-12"	14800
Grassy	SOIL	RSB9	0-3"	14500
Grassy	SOIL	RSB-70	3-10"	13100
Grassy	SOIL	RSB51	0-3"	12600
Grassy	SED	RSED3	6-12"	8420
Grassy	SOIL	RSB-70	0-3"	6420
Grassy	SOIL	RSB50	0-3"	5470
Grassy	SOIL	RSB51	3-10"	4430
Grassy	SED	RSED2	6-12"	4080
Grassy	SOIL	RSB9	3-10"	3800
Grassy	SOIL	RSB51	24-30"	3300
Grassy	SOIL	RSB4	0-3"	2360
Grassy	SOIL	RSB24	0-3"	1980
Grassy	SOIL	RSB6	0-3"	1880
Grassy	SOIL	RSB10	0-3"	1850
Grassy	SOIL	BSB2	0-3"	1200
Grassy	SOIL	RSB7	0-3"	1150
Grassy	SOIL	RSB43	0-3"	1130

Construction Worker 1:

Station	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
Average	13,392	3,856
RSED4	243000	50
RSED5	228000	50
RSED5	182000	50
RSED3	95300	50
RSED2	73800	50
RSED7	46000	50
RSED8	34800	34800
RSED9	32400	32400
RSED1	29900	29900
RSED10	29300	29300
RSED8	25900	25900
RSED7	20500	20500
RSED1	19300	19300
RSED4	17300	17300
RSED10	15300	15300
RSED9	14800	14800
RSB9	14500	14500
RSB-70	13100	13100
RSB51	12600	12600
RSED3	8420	8420
RSB-70	6420	6420
RSB50	5470	5470
RSB51	4430	4430
RSED2	4080	4080
RSB9	3800	3800
RSB51	3300	3300
RSB4	2360	2360
RSB24	1980	1980
RSB6	1880	1880
RSB10	1850	1850
BSB2	1200	1200
RSB7	1150	1150
RSB43	1130	1130

Construction Worker 2:

Station	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
Average	13,392	567
RSED4	243000	50
RSED5	228000	50
RSED5	182000	50
RSED3	95300	50
RSED2	73800	50
RSED7	46000	50
RSED8	34800	50
RSED9	32400	50
RSED1	29900	50
RSED10	29300	50
RSED8	25900	50
RSED7	20500	50
RSED1	19300	50
RSED4	17300	50
RSED10	15300	50
RSED9	14800	50
RSB9	14500	50
RSB-70	13100	50
RSB51	12600	50
RSED3	8420	50
RSB-70	6420	50
RSB50	5470	50
RSB51	4430	4430
RSED2	4080	4080
RSB9	3800	3800
RSB51	3300	3300
RSB4	2360	2360
RSB24	1980	1980
RSB6	1880	1880
RSB10	1850	1850
BSB2	1200	1200
RSB7	1150	1150
RSB43	1130	1130

Grassy Area All Depths (0 - 30")
Soil and Sediment combined

Construction Worker 1	Lead (mg/kg)
PRG	4,600
RAL	43,300

Construction Worker 2	Lead (mg/kg)
PRG	920
RAL	4,954

Exposure Area	MATRIX	Station	DEPTH	Lead (mg/kg)
Grassy	SOIL	RSB2	0-3"	1100
Grassy	SOIL	BSB4	0-3"	1060
Grassy	SOIL	RSB49	0-3"	1060
Grassy	SOIL	RSB8	0-3"	1050
Grassy	SOIL	RSB5	0-3"	985
Grassy	SOIL	RSB40	0-3"	901
Grassy	SOIL	RSB50	3-10"	888
Grassy	SOIL	RSB30	0-3"	887
Grassy	SOIL	RSB1	0-3"	873
Grassy	SOIL	RSB50	24-30"	873
Grassy	SOIL	RSB42	0-3"	834
Grassy	SOIL	BSB4	3-10"	690
Grassy	SOIL	RSB4	3-10"	686
Grassy	SOIL	RSB13	0-3"	682
Grassy	SOIL	RSB49	3-10"	663
Grassy	SOIL	RSB16	0-3"	661
Grassy	SOIL	RSB11	0-3"	641
Grassy	SOIL	RSB3	0-3"	632
Grassy	SOIL	RSB3	3-10"	593
Grassy	SOIL	RSB21	0-3"	497
Grassy	SOIL	RSB45	0-3"	487
Grassy	SOIL	RSB46	0-3"	385
Grassy	SOIL	RSB44	0-3"	369
Grassy	SOIL	RSB5	3-10"	366
Grassy	SOIL	RSB41	0-3"	341
Grassy	SOIL	RSB8	3-10"	321
Grassy	SOIL	RSB6	3-10"	289
Grassy	SOIL	RSB24	3-10"	288
Grassy	SOIL	BSB1	24-30"	262
Grassy	SOIL	BSB3	0-3"	257
Grassy	SOIL	RSB10	3-10"	241
Grassy	SOIL	RSB45	3-10"	234
Grassy	SOIL	RSB7	3-10"	232

Station	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
Average	13,392	3,856
RSB2	1100	1100
BSB4	1060	1060
RSB49	1060	1060
RSB8	1050	1050
RSB5	985	985
RSB40	901	901
RSB50	888	888
RSB30	887	887
RSB1	873	873
RSB50	873	873
RSB42	834	834
BSB4	690	690
RSB4	686	686
RSB13	682	682
RSB49	663	663
RSB16	661	661
RSB11	641	641
RSB3	632	632
RSB3	593	593
RSB21	497	497
RSB45	487	487
RSB46	385	385
RSB44	369	369
RSB5	366	366
RSB41	341	341
RSB8	321	321
RSB6	289	289
RSB24	288	288
BSB1	262	262
BSB3	257	257
RSB10	241	241
RSB45	234	234
RSB7	232	232

Station	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
Average	13,392	567
RSB2	1100	1100
BSB4	1060	1060
RSB49	1060	1060
RSB8	1050	1050
RSB5	985	985
RSB40	901	901
RSB50	888	888
RSB30	887	887
RSB1	873	873
RSB50	873	873
RSB42	834	834
BSB4	690	690
RSB4	686	686
RSB13	682	682
RSB49	663	663
RSB16	661	661
RSB11	641	641
RSB3	632	632
RSB3	593	593
RSB21	497	497
RSB45	487	487
RSB46	385	385
RSB44	369	369
RSB5	366	366
RSB41	341	341
RSB8	321	321
RSB6	289	289
RSB24	288	288
BSB1	262	262
BSB3	257	257
RSB10	241	241
RSB45	234	234
RSB7	232	232

Grassy Area All Depths (0 - 30")
Soil and Sediment combined

Construction Worker 1	Lead (mg/kg)
PRG	4,600
RAL	43,300

Construction Worker 2	Lead (mg/kg)
PRG	920
RAL	4,954

Exposure Area	MATRIX	Station	DEPTH	Lead (mg/kg)
Grassy	SOIL	RSB43	3-10"	230
Grassy	SOIL	RSB39	0-3"	227
Grassy	SOIL	RSB36	0-3"	216
Grassy	SOIL	RSB46	3-10"	216
Grassy	SOIL	RSB1	3-10"	215
Grassy	SOIL	RSB42	3-10"	214
Grassy	SOIL	RSB2	3-10"	202
Grassy	SOIL	RSB49	24-30"	186
Grassy	SOIL	RSB40	3-10"	161
Grassy	SOIL	BSB1	0-3"	158
Grassy	SOIL	RSB30	3-10"	127
Grassy	SOIL	RSB21	3-10"	105
Grassy	SOIL	RSB11	3-10"	101
Grassy	SOIL	RSB13	3-10"	96
Grassy	SOIL	RSB16	3-10"	95
Grassy	SOIL	RSB41	3-10"	82
Grassy	SOIL	RSB39	3-10"	81
Grassy	SOIL	BSB2	3-10"	74
Grassy	SOIL	BSB1	3-10"	63
Grassy	SOIL	RSB36	3-10"	55
Grassy	SOIL	RSB44	3-10"	53
Grassy	SOIL	RSB35	0-3"	43
Grassy	SOIL	RSB35	3-10"	23
Grassy	SOIL	BSB3	3-10"	20
Grassy	SOIL	RSB-70	24-30"	11

Average	13,392	3,856
Station	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
RSB43	230	230
RSB39	227	227
RSB36	216	216
RSB46	216	216
RSB1	215	215
RSB42	214	214
RSB2	202	202
RSB49	186	186
RSB40	161	161
BSB1	158	158
RSB30	127	127
RSB21	105	105
RSB11	101	101
RSB13	96	96
RSB16	95	95
RSB41	82	82
RSB39	81	81
BSB2	74	74
BSB1	63	63
RSB36	55	55
RSB44	53	53
RSB35	43	43
RSB35	23	23
BSB3	20	20
RSB-70	11	11

Average	13,392	567
Station	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
RSB43	230	230
RSB39	227	227
RSB36	216	216
RSB46	216	216
RSB1	215	215
RSB42	214	214
RSB2	202	202
RSB49	186	186
RSB40	161	161
BSB1	158	158
RSB30	127	127
RSB21	105	105
RSB11	101	101
RSB13	96	96
RSB16	95	95
RSB41	82	82
RSB39	81	81
BSB2	74	74
BSB1	63	63
RSB36	55	55
RSB44	53	53
RSB35	43	43
RSB35	23	23
BSB3	20	20
RSB-70	11	11

Grassy Area Surface (0 - 6")
Sediment only

Trespasser	Lead (ppm)
PRG	10,417
RAL	34,000

MATRIX	Station	DEPTH	Lead (mg/kg)
SED	RSED4	0-6"	243000
SED	RSED5	0-6"	228000
SED	RSED3	0-6"	95300
SED	RSED2	0-6"	73800
SED	RSED7	0-6"	46000
SED	RSED8	0-6"	34800
SED	RSED9	0-6"	32400
SED	RSED10	0-6"	29300
SED	RSED1	0-6"	19300

Average	89,100	9,033
Station	Pre-Remediation Conc. (mg/kg)	Post-Remediation Conc. (mg/kg)
RSED4	243000	50
RSED5	228000	50
RSED3	95300	50
RSED2	73800	50
RSED7	46000	50
RSED8	34800	50
RSED9	32400	32400
RSED10	29300	29300
RSED1	19300	19300

Arlington Ave
Sediment Data

MATRIX	Station	SAMPLE ID	DEPTH	Lead (mg/kg)
SED	R2SED-1	R2SED-1A	0-6"	1210
SED	R2SED-2	R2SED-2A	0-6"	1230
SED	R2SED-3	R2SED-3A	0-6"	1570
SED	R2SED-4	R2SED-4A	0-6"	2480
SED	R2SED-5	R2SED-5A	0-6"	5030
SED	R2SED-5	R2SED-5A	0-6"	5410
SED	R2SED-6	R2SED-6A	0-6"	8430
SED	R2SED-7	R2SED-7A	0-6"	5480
SED	R2SED-8	R2SED-8A	0-6"	8190
SED	R2SED-9	R2SED-9A	0-6"	3630
SED	R2SED-10	R2SED-10A	0-6"	84
SED	R2SED-11	R2SED-11-0-6	0-6"	874
SED	R2SED-12	R2SED-12-0-6	0-6"	411
SED	R2SED-13	R2SED-13-0-6	0-6"	771
SED	R2SED-14	R2SED-14-0-6	0-6"	681
			Average	**3032**

Railroad Ditch
Lead Data in Sediment

MATRIX	Station	SAMPLE ID	DEPTH	Lead (mg/kg)
SED	R2SB30	R2SB30-0-3	0-3"	1810
SED	R2SB29	R2SB29-0-3	0-3"	14800
SED	R2SB28	R2SB28-0-3	0-3"	684
SED	R2SB27	R2SB27-0-3	0-3"	786
SED	R2SB26	R2SB26-0-3	0-3"	12200
SED	R2SB25	R2SB25-0-3	0-3"	617
			Average	**5150**

Appendix C
Arsenic Data Sets
and
EPC Calculations

Exide Beech Grove
Exposure Point Concentrations

Exposure Area	Receptor	Media	Depth	Arsenic 95% UCL mg/kg	Arsenic 95% UCL Basis	Lead Mean mg/kg
Onsite	Construction Worker 1 & 2, Utility Worker	Soil	0-5 ft	123	NP, Bootstrap	20,266
Grassy Area	Trespasser	Soil	0-6 in	60	NP, Chebyshev 95% UCL	1,908
	Trespasser	Sediment	0-6 in	1,387	Gamma UCL	89,100
	Groundskeeper, Worker	Soil and Sediment	0-6 in	779	NP, Chebyshev 99% UCL	20,158
	Construction Worker 1 & 2	Soil and Sediment	0-30 in	818	NP, Chebyshev 99% UCL	13,392
Offsite Gas Facility	Worker	Soil	0-6 in	28.5	LN. H-UCL	1,311
Arlington Ave	Recreator	Sediment	0-3 in	38	NP, Chebyshev 95% UCL	3,032
Railroad Ditch	Recreator	Sediment	0-3 in	169	Max	5,150

Notes:
NP Nonparametric
LN Lognormal

Onsite Soil (0-5 ft)
Individual Sample Data

Station	SAMPLE ID	Year	DEPTH	As Conc (mg/kg)
RSED6	RSED6A	1999	0-6"	305
RSED6	RSED6B	1999	6-12"	114
CSB30	CSB-30A-C	2001	12-15"	9.1
CSB3	CSB3B	1999	6-9"	565
CSB3	CSB3C	1999	12-15"	217
CSB3	CSB3D	1999	24-28"	193
CSB3	CSB3E	1999	36-39"	12
CSB30	CSB-30A-E	2001	36-39"	6.6
CSB30	CSB30B	1999	6-9"	6.7
CSB30	CSB30A	1999	0-3"	9.5
CSB3	CSB3A	1999	0-3"	284
CSB30	CSB-30A-D	2001	24-27"	6.6
CSB29	CSB29C	1999	12-15"	11
CSB30	CSB-30A-B	2001	6-9"	13
CSB30	CSB-30A-A	2001	0-3"	30
CSB31	CSB31A	1999	0-3"	14
CSB31	CSB31C	1999	12-15"	6.7
CSB31	CSB31B	1999	6-9"	22
CSB32	CSB-32A-B	2001	6-9"	199
CSB30	CSB30C	1999	12-15"	11
CSB28	CSB28A	1999	0-3"	4.4
CSB-26	CSB-26A-E	2001	36-39"	5.8
CSB-26	CSB-26A-D	2001	24-27"	6.2
CSB-26	CSB-26A-C	2001	12-15"	6.4
CSB-26	CSB-26A-A	2001	0-3"	12
CSB27	CSB27C	1999	12-15"	6.4
CSB27	CSB27B	1999	6-9"	8.5
CSB27	CSB27A	1999	0-3"	6.3
CSB29	CSB29A	1999	0-3"	9.2
CSB28	CSB28C	1999	12-15"	23
CSB1	CSB1A	1999	0-3"	406
CSB28	CSB-28A-D	2001	24-27"	6.5
CSB28	CSB-28A-B	2001	6-9"	5.1
CSB28	CSB-28A-A	2001	0-3"	53
CSB28	CSB28B	1999	6-9"	10
CSB28	CSB-28A-E	2001	36-39"	9.4
CSB32	CSB-32A-D	2001	24-27"	8
CSB29	CSB29B	1999	6-9"	25
CSB28	CSB-28A-C	2001	12-15"	7.9
CSB37	CSB37B	1999	6-9"	7.9
CSB35	CSB-35A-D	2001	24-27"	6
CSB35	CSB-35A-C	2001	12-15"	408
CSB35	CSB-35A-B	2001	6-9"	6.1
CSB35	CSB-35A-A	2001	0-3"	154
CSB36	CSB36A	1999	0-3"	170
CSB36	CSB36C	1999	12-15"	12
CSB32	CSB-32A-E	2001	36-39"	6.5
CSB37	CSB37A	1999	0-3"	30
CSB35	CSB35A	1999	0-3"	8.4
CSB37	CSB37C	1999	12-15"	6.8
CSB38	CSB-38A-E	2001	36-39"	8.6
CSB38	CSB-38A-A	2001	0-3"	67
CSB38	CSB-38A-B	2001	6-9"	7.9
CSB38	CSB-38A-C	2001	12-15"	9.3
CSB38	CSB-38A-D	2001	24-27"	2.5
CSB38	CSB38B	1999	6-9"	4.4
CSB36	CSB36B	1999	6-9"	15
CSB34	CSB34C	1999	12-15"	7

Onsite Soil (0-5 ft)
Data Averaged by Location

Station	Year	Num Samples	As Avg Conc (mg/kg)
RSB71	1999	1	215.0
RSB22	1999	2	15.5
RSB37	1999	2	15.0
RSB33	1999	2	33.0
RSB31	1999	2	217.0
RSB29	1999	2	17.0
RSB28	1999	2	36.0
RSB27	1999	2	7.3
RSB26	1999	2	179.5
RSB38	1999	2	10.6
RSB23	1999	2	10.3
RSB34	1999	2	6.4
RSB20	1999	2	12.0
RSB19	1999	2	6.9
RSB18	1999	2	7.1
RSB17	1999	2	9.9
RSB15	1999	2	16.0
RSB14	1999	2	19.5
RSB12	1999	2	110.0
RSED6	1999	2	209.5
RSB25	1999	2	485.5
RSB32	1999	2	10.4
CSB33	1999	3	12.7
CSB15	1999	3	6.7
CSB14	1999	3	4.8
CSB13	1999	3	19.7
CSB12	1999	3	1111.3
CSB17	1999	3	7.1
CSB32	1999	3	134.1
CSB18	1999	3	7.4
CSB34	1999	3	68.4
CSB11	1999	3	278.7
CSB36	1999	3	65.7
CSB37	1999	3	14.9
CSB38	1999	3	5.7
CSB39	1999	3	292.3
CSB31	1999	3	14.2
CSB24	1999	3	6.2
CSB30	1999	3	9.1
CSB28	1999	3	12.5
CSB27	1999	3	7.1
CSB50	1999	3	12.7
CSB26	1999	3	7.6
CSB16	1999	3	6.9
CSB25	1999	3	32.3
CSB29	1999	3	15.1
CSB23	1999	3	6.9
CSB22	1999	3	6.5
CSB21	1999	3	8.0
CSB20	1999	3	6.3
CSB2	1999	3	298.0
CSB19	1999	3	7.5
CSB4	1999	3	286.9
RSB78	1999	3	13.0
CSB40	1999	3	18.8
RSB57	1999	3	126.0
RSB58	1999	3	161.3
RSB72	1999	3	8.0

Onsite Soil (0-5 ft)
Individual Sample Data

Station	SAMPLE ID	Year	DEPTH	As Conc (mg/kg)
CSB26	CSB26A	1999	0-3"	7.7
CSB32	CSB-32A-C	2001	12-15"	230
CSB32	CSB32B	1999	6-9"	7.4
CSB32	CSB32A	1999	0-3"	388
CSB32	CSB32C	1999	12-15"	7
CSB33	CSB33C	1999	12-15"	13
CSB33	CSB33B	1999	6-9"	12
CSB35	CSB-35A-E	2001	36-39"	6.3
CSB34	CSB34B	1999	6-9"	9.1
CSB35	CSB-35A-F	2001	48-51"	6.3
CSB34	CSB34A	1999	0-3"	189
CSB35	CSB35E	1999	36-39"	15
CSB35	CSB35D	1999	24-28"	12
CSB35	CSB35F	1999	48-51"	12
CSB35	CSB35C	1999	12-15"	7
CSB35	CSB35B	1999	6-9"	9.5
CSB32	CSB-32A-A	2001	0-3"	394
CSB33	CSB33A	1999	0-3"	13
CSB13	CSB-13A-E	2001	36-39"	6
CSB11	CSB11A	1999	0-3"	237
CSB11	CSB11C	1999	12-15"	14
CSB12	CSB12C	1999	12-15"	14
CSB12	CSB12B	1999	6-9"	2270
CSB12	CSB12A	1999	0-3"	1050
CSB13	CSB-13A-B	2001	6-9"	22
CSB-26	CSB-26A-B	2001	6-9"	11
CSB13	CSB-13A-C	2001	12-15"	6.6
CSB-10	CSB-10A-F	2001	48-51"	1700
CSB13	CSB-13A-D	2001	24-27"	5.9
CSB13	CSB13A	1999	0-3"	38
CSB13	CSB13B	1999	6-9"	11
CSB13	CSB13C	1999	12-15"	10
CSB14	CSB14A	1999	0-3"	2.2
CSB14	CSB14C	1999	12-15"	6.4
CSB14	CSB14B	1999	6-9"	5.7
CSB13	CSB-13A-A	2001	0-3"	11
CSB-10	CSB10A	1999	0-3"	709
CSB1	CSB1B	1999	6-9"	599
CSB1	CSB1C	1999	12-15"	8
CSB1	CSB-1A-F	2001	48-51"	8.5
CSB1	CSB-1A-B	2001	6-9"	1.5
CSB1	CSB-1A-C	2001	12-15"	1.5
CSB1	CSB-1A-A	2001	0-3"	3.2
CSB1	CSB-1A-D	2001	24-27"	989
CSB11	CSB11B	1999	6-9"	585
CSB-10	CSB-10A-C	2001	12-15"	433
CSB-10	CSB-10A-A	2001	0-3"	4.5
CSB-10	CSB10B	1999	6-9"	916
CSB-10	CSB10C	1999	12-15"	17
CSB-10	CSB-10A-B	2001	6-9"	6.1
CSB-10	CSB-10A-E	2001	36-39"	7.1
CSB-10	CSB-10A-D	2001	24-27"	2730
CSB-10	CSB10D	1999	12-15"	6.9
CSB15	CSB15B	1999	6-9"	7.8
CSB1	CSB-1A-E	2001	36-39"	6.8
CSB24	CSB24A	1999	0-3"	4.8
CSB15	CSB15C	1999	12-15"	5.3
CSB21	CSB21B	1999	6-9"	9.3

Onsite Soil (0-5 ft)
Data Averaged by Location

Station	Year	Num Samples	As Avg Conc (mg/kg)
RSB73	1999	3	12.2
RSB74	1999	3	9.0
RSB75	1999	3	28.3
RSB55	1999	3	247.3
RSB77	1999	3	7.1
RSB56	1999	3	7.5
RSB79	1999	3	7.8
RSB80	1999	3	7.0
RSB81	1999	3	8.6
RSB82	1999	3	13.9
RSB83	1999	3	11.1
RSB84	1999	3	10.2
RSB85	1999	3	6.9
RSB76	1999	3	13.9
RSB54	1999	3	68.1
CSB42	1999	3	34.6
RSB53	1999	3	7.8
RSB52	1999	3	6.5
CSB49	1999	3	7.1
CSB9	1999	3	10.2
CSB8	1999	3	28.7
CSB6	1999	3	9.8
CSB1	1999	3	337.7
CSB41	1999	3	6.2
CSB5	1999	3	6.5
CSB-10	1999	4	412.2
CSB38	2001	5	19.1
CSB13	2001	5	10.3
CSB-26	2001	5	8.3
CSB32	2001	5	167.5
CSB30	2001	5	13.1
CSB3	1999	5	254.2
CSB28	2001	5	16.4
CSB7	1999	5	245.0
CSB1	2001	6	168.4
CSB-10	2001	6	813.5
CSB35	1999	6	10.7
CSB51	1999	6	91.5
CSB35	2001	6	97.8

Onsite Soil (0-5 ft)
Individual Sample Data

Station	SAMPLE ID	Year	DEPTH	As Conc (mg/kg)
CSB21	CSB21A	1999	0-3"	7.8
CSB22	CSB22B	1999	6-9"	6.7
CSB22	CSB22A	1999	0-3"	6.3
CSB22	CSB22C	1999	12-15"	6.6
CSB23	CSB23A	1999	0-3"	7.5
CSB20	CSB20A	1999	0-3"	9.6
CSB23	CSB23C	1999	12-15"	6.2
CSB20	CSB20B	1999	6-9"	6.9
CSB24	CSB24B	1999	6-9"	9.3
CSB24	CSB24C	1999	12-15"	4.4
CSB25	CSB25B	1999	6-9"	75
CSB25	CSB25C	1999	12-15"	8.8
CSB25	CSB25A	1999	0-3"	13
CSB26	CSB26B	1999	6-9"	6.5
CSB39	CSB39A	1999	0-3"	863
CSB23	CSB23B	1999	6-9"	7
CSB18	CSB18C	1999	12-15"	8.3
CSB26	CSB26C	1999	12-15"	8.6
CSB16	CSB16C	1999	12-15"	7.5
CSB16	CSB16A	1999	0-3"	6
CSB16	CSB16B	1999	6-9"	7.2
CSB17	CSB17A	1999	0-3"	7.3
CSB17	CSB17B	1999	6-9"	7.1
CSB17	CSB17C	1999	12-15"	6.9
CSB21	CSB21C	1999	12-15"	6.8
CSB18	CSB18A	1999	0-3"	7.8
CSB15	CSB15A	1999	0-3"	7
CSB19	CSB19A	1999	0-3"	9
CSB19	CSB19C	1999	12-15"	6.7
CSB19	CSB19B	1999	6-9"	6.8
CSB2	CSB2B	1999	6-9"	159
CSB2	CSB2C	1999	12-15"	469
CSB2	CSB2A	1999	0-3"	266
CSB20	CSB20C	1999	12-15"	2.4
CSB18	CSB18B	1999	6-9"	6
RSB58	RSB58A	1999	0-3"	247
RSB55	RSB55B	1999	3-10"	359
RSB56	RSB56B	1999	3-10"	7.7
RSB56	RSB56C	1999	24-30"	6.1
RSB56	RSB56A	1999	0-3"	8.6
RSB57	RSB57C	1999	24-30"	16
RSB57	RSB57B	1999	3-10"	127
RSB73	RSB73C	1999	24-30"	7.6
RSB58	RSB58C	1999	24-30"	37
RSB54	RSB54A	1999	0-3"	107
RSB58	RSB58B	1999	3-10"	200
RSB71	RSB71A	1999	0-3"	215
RSB72	RSB72A	1999	0-3"	8.7
RSB72	RSB72B	1999	3-10"	7
RSB72	RSB72C	1999	24-30"	8.2
RSB73	RSB73A	1999	0-3"	18
CSB38	CSB38A	1999	0-3"	4.9
RSB57	RSB57A	1999	0-3"	235
RSB52	RSB52A	1999	0-3"	6.6
RSB33	RSB33A	1999	0-3"	56
RSB33	RSB33B	1999	3-10"	10
RSB34	RSB34A	1999	0-3"	6.5
RSB34	RSB34B	1999	3-10"	6.3

Onsite Soil (0-5 ft)
Data Averaged by Location

Station	Year	Num Samples	As Avg Conc (mg/kg)

Onsite Soil (0-5 ft)
Individual Sample Data

Station	SAMPLE ID	Year	DEPTH	As Conc (mg/kg)
RSB37	RSB37B	1999	3-10"	13
RSB37	RSB37A	1999	0-3"	17
RSB38	RSB38A	1999	0-3"	14
RSB55	RSB55A	1999	0-3"	323
RSB52	RSB52C	1999	24-30"	6.9
RSB55	RSB55C	1999	24-30"	60
RSB52	RSB52B	1999	3-10"	5.9
RSB53	RSB53B	1999	3-10"	8.3
RSB53	RSB53C	1999	24-30"	6.9
RSB53	RSB53A	1999	0-3"	8.2
RSB54	RSB54C	1999	24-30"	3.4
RSB54	RSB54B	1999	3-10"	94
RSB74	RSB74A	1999	0-3"	13
RSB38	RSB38B	1999	3-10"	7.2
RSB83	RSB83C	1999	24-30"	16
RSB80	RSB80A	1999	0-3"	7.4
RSB81	RSB81A	1999	0-3"	9.4
RSB81	RSB81B	1999	3-10"	9.3
RSB81	RSB81C	1999	24-30"	7
RSB82	RSB82C	1999	24-30"	9.3
RSB82	RSB82B	1999	3-10"	24
RSB73	RSB73B	1999	3-10"	11
RSB83	RSB83B	1999	3-10"	7.4
RSB79	RSB79A	1999	0-3"	8.5
RSB83	RSB83A	1999	0-3"	9.9
RSB84	RSB84C	1999	24-30"	5.7
RSB84	RSB84A	1999	0-3"	10
RSB84	RSB84B	1999	3-10"	15
RSB85	RSB85B	1999	3-10"	6.7
RSB85	RSB85C	1999	24-30"	7
RSB85	RSB85A	1999	0-3"	7.1
RSB82	RSB82A	1999	0-3"	8.5
RSB77	RSB77A	1999	0-3"	7
RSB74	RSB74C	1999	24-30"	4.9
RSB74	RSB74B	1999	3-10"	9
RSB75	RSB75C	1999	24-30"	12
RSB75	RSB75B	1999	3-10"	15
RSB75	RSB75A	1999	0-3"	58
RSB76	RSB76B	1999	3-10"	10
RSB76	RSB76A	1999	0-3"	24
RSB80	RSB80B	1999	3-10"	7
RSB77	RSB77B	1999	3-10"	7.7
RSB80	RSB80C	1999	24-30"	6.7
RSB77	RSB77C	1999	24-30"	6.6
RSB78	RSB78A	1999	0-3"	14
RSB78	RSB78B	1999	3-10"	12
RSB78	RSB78C	1999	24-30"	13
RSB79	RSB79B	1999	3-10"	6.9
RSB79	RSB79C	1999	24-30"	8.1
RSB31	RSB31A	1999	0-3"	202
RSB76	RSB76C	1999	24-30"	7.7
CSB51	CSB51B	1999	6-9"	187
CSB5	CSB5A	1999	0-3"	7.2
CSB50	CSB50C	1999	12-15"	10
CSB50	CSB50A	1999	0-3"	15
CSB50	CSB50B	1999	6-9"	13
CSB51	CSB51F	1999	48-51"	18
CSB51	CSB51E	1999	36-39"	26

Onsite Soil (0-5 ft)
Data Averaged by Location

Station	Year	Num Samples	As Avg Conc (mg/kg)

Onsite Soil (0-5 ft)
Individual Sample Data

Station	SAMPLE ID	Year	DEPTH	As Conc (mg/kg)
RSB32	RSB32B	1999	3-10"	7.7
CSB51	CSB51A	1999	0-3"	265
CSB49	CSB49C	1999	12-15"	6.8
CSB51	CSB51C	1999	12-15"	17
CSB6	CSB6A	1999	0-3"	8.9
CSB6	CSB6C	1999	12-15"	11
CSB6	CSB6B	1999	6-9"	9.6
CSB7	CSB7B	1999	6-9"	788
CSB7	CSB7C	1999	12-15"	343
CSB7	CSB7A	1999	0-3"	81
CSB51	CSB51D	1999	24-28"	36
CSB41	CSB41A	1999	0-3"	4.8
CSB39	CSB39B	1999	6-9"	8
CSB39	CSB39C	1999	12-15"	5.8
CSB4	CSB4A	1999	0-3"	690
CSB4	CSB4B	1999	6-9"	164
CSB4	CSB4C	1999	12-15"	6.8
CSB40	CSB40C	1999	12-15"	11
CSB40	CSB40B	1999	6-9"	6.4
CSB5	CSB5B	1999	6-9"	7.1
CSB41	CSB41B	1999	6-9"	7.6
CSB5	CSB5C	1999	12-15"	5.1
CSB41	CSB41C	1999	12-15"	6.3
CSB42	CSB42B	1999	6-9"	73
CSB42	CSB42C	1999	12-15"	7.8
CSB42	CSB42A	1999	0-3"	23
CSB49	CSB49B	1999	6-9"	6.4
CSB49	CSB49A	1999	0-3"	8.1
CSB8	CSB8C	1999	12-15"	10
CSB40	CSB40A	1999	0-3"	39
RSB27	RSB27B	1999	3-10"	6.5
CSB7	CSB7E	1999	36-39"	6.2
RSB22	RSB22B	1999	3-10"	10
RSB22	RSB22A	1999	0-3"	21
RSB23	RSB23A	1999	0-3"	18
RSB23	RSB23B	1999	3-10"	2.6
RSB25	RSB25B	1999	3-10"	104
RSB25	RSB25A	1999	0-3"	867
RSB20	RSB20A	1999	0-3"	14
RSB26	RSB26A	1999	0-3"	175
RSB19	RSB19B	1999	3-10"	6.8
RSB27	RSB27A	1999	0-3"	8.1
RSB28	RSB28B	1999	3-10"	16
RSB28	RSB28A	1999	0-3"	56
RSB29	RSB29A	1999	0-3"	23
RSB29	RSB29B	1999	3-10"	11
RSB31	RSB31B	1999	3-10"	232
CSB38	CSB38C	1999	12-15"	7.8
RSB26	RSB26B	1999	3-10"	184
RSB14	RSB14A	1999	0-3"	24
RSB32	RSB32A	1999	0-3"	13
CSB8	CSB8A	1999	0-3"	66
CSB8	CSB8B	1999	6-9"	10
CSB9	CSB9A	1999	0-3"	12
CSB9	CSB9B	1999	6-9"	11
CSB9	CSB9C	1999	12-15"	7.7
RSB12	RSB12B	1999	3-10"	125
RSB20	RSB20B	1999	3-10"	10

Onsite Soil (0-5 ft)
Data Averaged by Location

Station	Year	Num Samples	As Avg Conc (mg/kg)

Onsite Soil (0-5 ft)
Individual Sample Data

Station	SAMPLE ID	Year	DEPTH	As Conc (mg/kg)
RSB14	RSB14B	1999	3-10"	15
CSB7	CSB7D	1999	24-28"	6.9
RSB15	RSB15A	1999	0-3"	22
RSB15	RSB15B	1999	3-10"	10
RSB17	RSB17B	1999	3-10"	9.7
RSB17	RSB17A	1999	0-3"	10
RSB18	RSB18B	1999	3-10"	6.3
RSB18	RSB18A	1999	0-3"	7.8
RSB19	RSB19A	1999	0-3"	7
RSB12	RSB12A	1999	0-3"	95

Onsite Soil (0-5 ft)
Data Averaged by Location

Station	Year	Num Samples	As Avg Conc (mg/kg)

Offsite Gas Facility
Arsenic Data

Matrix	Station	DEPTH	Arsenic (mg/kg)
SOIL	R2SB-12	0-3"	11
SOIL	R2SB-19	0-3"	16
SOIL	R2SB-18	0-3"	10
SOIL	R2SB-17	0-3"	25
SOIL	R2SB-16	0-3"	7.7
SOIL	R2SB-15	0-3"	4.8
SOIL	R2SB-14	0-3"	8.6
SOIL	R2BG-1	0-3"	9.8
SOIL	R2SB-13	0-3"	53
SOIL	R2SB-20	0-3"	9.6
SOIL	R2SB-11	0-3"	14
SOIL	R2SB-10	0-3"	8.9
SOIL	R2SB-1	0-3"	58
SOIL	R2SB-1	0-3"	141
SOIL	R2BG-4	0-3"	3.1
SOIL	R2BG-3	0-3"	6
SOIL	R2BG-2	0-3"	10
SOIL	R2SB-13	0-3"	14
SOIL	R2SB-4	0-3"	26
SOIL	RSB-64	0-3"	32
SOIL	RSB-63	0-3"	16
SOIL	R2SB-9	0-3"	47
SOIL	R2SB-8	0-3"	13
SOIL	R2SB-7	0-3"	9.6
SOIL	R2SB-6	0-3"	12
SOIL	R2SB-52	0-3"	4.6
SOIL	R2SB-2	0-3"	19
SOIL	R2SB-4	0-3"	28
SOIL	R2SB-2	0-3"	16
SOIL	R2SB-3	0-3"	38
SOIL	R2SB-3	0-3"	36
SOIL	R2SB-24	0-3"	13
SOIL	R2SB-23	0-3"	10
SOIL	R2SB-22	0-3"	13
SOIL	R2SB-21	0-3"	10
SOIL	RSB-69	0-3"	55
SOIL	R2SB-5	0-3"	10

Grassy Area Surface Soil and Sediment (0-6")

MATRIX	DEPTH	Station	PARAMETER	As Conc. (mg/kg)
SOIL	0-3"	BSB1	Arsenic	5.5
SOIL	0-3"	BSB2	Arsenic	13
SOIL	0-3"	BSB3	Arsenic	7
SOIL	0-3"	BSB4	Arsenic	16
SOIL	0-3"	RSB1	Arsenic	11
SOIL	0-3"	RSB10	Arsenic	14
SOIL	0-3"	RSB11	Arsenic	13
SOIL	0-3"	RSB13	Arsenic	11
SOIL	0-3"	RSB16	Arsenic	13
SOIL	0-3"	RSB2	Arsenic	14
SOIL	0-3"	RSB21	Arsenic	8.3
SOIL	0-3"	RSB24	Arsenic	20
SOIL	0-3"	RSB3	Arsenic	9.1
SOIL	0-3"	RSB30	Arsenic	15
SOIL	0-3"	RSB35	Arsenic	10
SOIL	0-3"	RSB36	Arsenic	9.2
SOIL	0-3"	RSB39	Arsenic	10
SOIL	0-3"	RSB4	Arsenic	22
SOIL	0-3"	RSB40	Arsenic	19
SOIL	0-3"	RSB41	Arsenic	10
SOIL	0-3"	RSB42	Arsenic	15
SOIL	0-3"	RSB43	Arsenic	20
SOIL	0-3"	RSB44	Arsenic	9.5
SOIL	0-3"	RSB45	Arsenic	6.1
SOIL	0-3"	RSB46	Arsenic	3.9
SOIL	0-3"	RSB49	Arsenic	20
SOIL	0-3"	RSB5	Arsenic	10
SOIL	0-3"	RSB50	Arsenic	38
SOIL	0-3"	RSB51	Arsenic	169
SOIL	0-3"	RSB6	Arsenic	22
SOIL	0-3"	RSB7	Arsenic	14
SOIL	0-3"	RSB-70	Arsenic	212
SOIL	0-3"	RSB8	Arsenic	23
SOIL	0-3"	RSB9	Arsenic	96
SED	0-6"	RSED1	Arsenic	310
SED	0-6"	RSED10	Arsenic	96
SED	0-6"	RSED2	Arsenic	713
SED	0-6"	RSED3	Arsenic	740
SED	0-6"	RSED4	Arsenic	2300
SED	0-6"	RSED5	Arsenic	1230
SED	0-6"	RSED7	Arsenic	170
SED	0-6"	RSED8	Arsenic	159
SED	0-6"	RSED9	Arsenic	124

Grassy Area Soil (0-30")

MATRIX	Station	Avg As Conc (mg/kg)	N
SOIL	BSB1	7.13	3
SOIL	BSB2	9.05	2
SOIL	BSB3	6.20	2
SOIL	BSB4	14.00	2
SOIL	RSB1	8.60	2
SOIL	RSB10	10.30	2
SOIL	RSB11	9.05	2
SOIL	RSB13	8.00	2
SOIL	RSB16	9.30	2
SOIL	RSB2	10.30	2
SOIL	RSB21	7.75	2
SOIL	RSB24	13.25	2
SOIL	RSB3	8.05	2
SOIL	RSB30	11.20	2
SOIL	RSB35	8.20	2
SOIL	RSB36	7.45	2
SOIL	RSB39	8.80	2
SOIL	RSB4	15.90	2
SOIL	RSB40	13.00	2
SOIL	RSB41	7.85	2
SOIL	RSB42	11.15	2
SOIL	RSB43	15.50	2
SOIL	RSB44	9.20	2
SOIL	RSB45	8.05	2
SOIL	RSB46	4.65	2
SOIL	RSB49	10.70	2
SOIL	RSB5	8.75	2
SOIL	RSB50	19.67	3
SOIL	RSB51	96.33	3
SOIL	RSB6	15.50	2
SOIL	RSB7	10.40	2
SOIL	RSB-70	180.17	3
SOIL	RSB8	16.05	2
SOIL	RSB9	61.50	2
SED	RSED1	286.50	2
SED	RSED10	78.50	2
SED	RSED2	471.00	2
SED	RSED3	462.00	2
SED	RSED4	1415.50	2
SED	RSED5	2555.00	2
SED	RSED7	124.00	2
SED	RSED8	131.00	2
SED	RSED9	87.00	2

Grassy Area Surface Soil (0-6")

MATRIX	DEPTH	Station	As Conc. (mg/kg)
SOIL	0-3"	BSB1	5.5
SOIL	0-3"	BSB2	13
SOIL	0-3"	BSB3	7
SOIL	0-3"	BSB4	16
SOIL	0-3"	RSB1	11
SOIL	0-3"	RSB10	14
SOIL	0-3"	RSB11	13
SOIL	0-3"	RSB13	11
SOIL	0-3"	RSB16	13
SOIL	0-3"	RSB2	14
SOIL	0-3"	RSB21	8.3
SOIL	0-3"	RSB24	20
SOIL	0-3"	RSB3	9.1
SOIL	0-3"	RSB30	15
SOIL	0-3"	RSB35	10
SOIL	0-3"	RSB36	9.2
SOIL	0-3"	RSB39	10
SOIL	0-3"	RSB4	22
SOIL	0-3"	RSB40	19
SOIL	0-3"	RSB41	10
SOIL	0-3"	RSB42	15
SOIL	0-3"	RSB43	20
SOIL	0-3"	RSB44	9.5
SOIL	0-3"	RSB45	6.1
SOIL	0-3"	RSB46	3.9
SOIL	0-3"	RSB49	20
SOIL	0-3"	RSB5	10
SOIL	0-3"	RSB50	38
SOIL	0-3"	RSB51	169
SOIL	0-3"	RSB6	22
SOIL	0-3"	RSB7	14
SOIL	0-3"	RSB-70	212
SOIL	0-3"	RSB8	23
SOIL	0-3"	RSB9	96

Grassy Area Sediment

MATRIX	DEPTH	Station	As Conc. (mg/kg)
SED	0-6"	RSED1	310
SED	0-6"	RSED10	96
SED	0-6"	RSED2	713
SED	0-6"	RSED3	740
SED	0-6"	RSED4	2300
SED	0-6"	RSED5	1230
SED	0-6"	RSED7	170
SED	0-6"	RSED8	159
SED	0-6"	RSED9	124

Arlington Ave Sediment

MATRIX	Station	DEPTH	As Conc. (mg/kg)
SED	R2SED-1	0-6"	10
SED	R2SED-10	0-6"	9.4
SED	R2SED-11	0-6"	12
SED	R2SED-12	0-6"	11
SED	R2SED-13	0-6"	12
SED	R2SED-14	0-6"	11
SED	R2SED-2	0-6"	10
SED	R2SED-3	0-6"	12
SED	R2SED-4	0-6"	20
SED	R2SED-5	0-6"	46
SED	R2SED-6	0-6"	44
SED	R2SED-7	0-6"	39
SED	R2SED-8	0-6"	36
SED	R2SED-9	0-6"	29

Railroad Ditch Sediment

MATRIX	Station	DEPTH	As Conc. (mg/kg)
SED	R2SB25	0-3"	23
SED	R2SB26	0-3"	169
SED	R2SB27	0-3"	25
SED	R2SB28	0-3"	23
SED	R2SB29	0-3"	154
SED	R2SB30	0-3"	12

Onsite Main Facility Area Soil (0 - 5 ft)

Summary Statistics for	Site- avg
Number of Samples	97
Minimum	4.8
Maximum	1111.3
Mean	82.4
Median	13.0
Standard Deviation	165.2
Variance	27306.7
Coefficient of Variation	2.0
Skewness	3.8
95 % UCL (Assuming Normal Data)	
Student's-t	110.3
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	117.0
Modified-t	111.3
95 % Non-parametric UCL	
CLT	110.0
Jackknife	110.3
Standard Bootstrap	110.1
Bootstrap-t	**123.2**
Chebyshev (Mean, Std)	155.5

Summary Statistics for	ln(Site- avg)
Minimum	1.6
Maximum	7.0
Mean	3.2
Standard Deviation	1.4
Variance	2.1
Lilliefors Test Statisitic	0.2
Lilliefors 5% Critical Value	0.1
Data not Lognormal at 5% Significance Level	
Data not Normal: Try Non-parametric UCL	
Estimates Assuming Lognormal Distribution	
MLE Mean	68.6
MLE Standard Deviation	181.4
MLE Coefficient of Variation	2.6
MLE Skewness	26.5
MLE Median	24.2
MLE 80% Quantile	82.0
MLE 90% Quantile	154.6
MLE 95% Quantile	259.8
MLE 99% Quantile	693.7
MVU Estimate of Median	24.0
MVU Estimate of Mean	67.1
MVU Estimate of Std. Dev.	162.7
MVU Estimate of SE of Mean	13.4
UCL Assuming Lognormal Distribution	
95% H-UCL	101.4
95% Chebyshev (MVUE) UCL	125.5
99% Chebyshev (MVUE) UCL	200.3

Note: Data are averaged by boring location first, before being run in the ProUCL program.

Grassy Area UCL Calculations

Data File

Variable: **Groundskeeper/Worker**

Raw Statistics	
Number of Valid Samples	43
Number of Unique Samples	30
Minimum	3.9
Maximum	2300
Mean	157.0
Median	15.0
Standard Deviation	410.1
Variance	168192.5
Coefficient of Variation	2.6
Skewness	4.1

Gamma Statistics	
k hat	0.4
k star (bias corrected)	0.4
Theta hat	392.3
Theta star	404.8
nu hat	34.4
nu star	33.3
Approx.Chi Square Value (.05)	21.1
Adjusted Level of Significance	0.0
Adjusted Chi Square Value	20.8

Log-transformed Statistics	
Minimum of log data	1.4
Maximum of log data	7.7
Mean of log data	3.4
Standard Deviation of log data	1.6
Variance of log data	2.5

RECOMMENDATION

Data are Non-parametric (0.05)

Use 99% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.4
Shapiro-Wilk 5% Critical Value	0.9
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	262.2

Gamma Distribution Test	
A-D Test Statistic	5.3
A-D 5% Critical Value	0.8
K-S Test Statistic	0.3
K-S 5% Critical Value	0.1
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	247.6
Adjusted Gamma UCL	251.7

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.8
Shapiro-Wilk 5% Critical Value	0.9
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	228.7
95% Chebyshev (MVUE) UCL	243.5
97.5% Chebyshev (MVUE) UCL	305.1
99% Chebyshev (MVUE) UCL	426.2

95% Non-parametric UCLs	
CLT UCL	259.9
Adj-CLT UCL (Adjusted for skewness)	301.8
Mod-t UCL (Adjusted for skewness)	268.7
Jackknife UCL	262.2
Standard Bootstrap UCL	258.1
Bootstrap-t UCL	377.9
Hall's Bootstrap UCL	598.5
Percentile Bootstrap UCL	266.8
BCA Bootstrap UCL	315.5
95% Chebyshev (Mean, Sd) UCL	429.6
97.5% Chebyshev (Mean, Sd) UCL	547.6
99% Chebyshev (Mean, Sd) UCL	**779.3**

Data File

Variable: **Const Worker 1& 2**

Raw Statistics	
Number of Valid Samples	43
Number of Unique Samples	39
Minimum	4.65
Maximum	2555
Mean	145.8
Median	11.15
Standard Deviation	442.7
Variance	195948.8
Coefficient of Variation	3.0
Skewness	4.6

Gamma Statistics	
k hat	0.4
k star (bias corrected)	0.4
Theta hat	395.1
Theta star	406.4
nu hat	31.7
nu star	30.9
Approx.Chi Square Value (.05)	19.2
Adjusted Level of Significance	0.0
Adjusted Chi Square Value	18.9

Log-transformed Statistics	
Minimum of log data	1.5
Maximum of log data	7.8
Mean of log data	3.2
Standard Deviation of log data	1.6
Variance of log data	2.5

RECOMMENDATION

Data are Non-parametric (0.05)

Use 99% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.4
Shapiro-Wilk 5% Critical Value	0.9
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	259.4

Gamma Distribution Test	
A-D Test Statistic	6.6
A-D 5% Critical Value	0.8
K-S Test Statistic	0.4
K-S 5% Critical Value	0.1
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	234.8
Adjusted Gamma UCL	238.8

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.8
Shapiro-Wilk 5% Critical Value	0.9
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	176.3
95% Chebyshev (MVUE) UCL	188.5
97.5% Chebyshev (MVUE) UCL	236.0
99% Chebyshev (MVUE) UCL	329.5

95% Non-parametric UCLs	
CLT UCL	256.9
Adj-CLT UCL (Adjusted for skewness)	307.6
Mod-t UCL (Adjusted for skewness)	267.3
Jackknife UCL	259.4
Standard Bootstrap UCL	258.9
Bootstrap-t UCL	560.8
Hall's Bootstrap UCL	681.5
Percentile Bootstrap UCL	271.2
BCA Bootstrap UCL	320.2
95% Chebyshev (Mean, Sd) UCL	440.1
97.5% Chebyshev (Mean, Sd) UCL	567.4
99% Chebyshev (Mean, Sd) UCL	**817.5**

Data File		Variable:	**Trespasser Soil**

Raw Statistics		Normal Distribution Test	
Number of Valid Samples	34	Shapiro-Wilk Test Statisitic	0.45
Number of Unique Samples	22	Shapiro-Wilk 5% Critical Value	0.93
Minimum	3.9	Data not normal at 5% significance level	
Maximum	212		
Mean	26.72	95% UCL (Assuming Normal Distribution)	
Median	13.5	Student's-t UCL	39.69
Standard Deviation	44.67		
Variance	1995.25	Gamma Distribution Test	
Coefficient of Variation	1.67	A-D Test Statistic	4.11
Skewness	3.42	A-D 5% Critical Value	0.77
		K-S Test Statistic	0.31
Gamma Statistics		K-S 5% Critical Value	0.16
k hat	1.06	Data do not follow gamma distribution	
k star (bias corrected)	0.99	at 5% significance level	
Theta hat	25.16		
Theta star	27.05	95% UCLs (Assuming Gamma Distribution)	
nu hat	72.23	Approximate Gamma UCL	36.41
nu star	67.19	Adjusted Gamma UCL	36.97
Approx.Chi Square Value (.05)	49.32		
Adjusted Level of Significance	0.04	Lognormal Distribution Test	
Adjusted Chi Square Value	48.56	Shapiro-Wilk Test Statisitic	0.84
		Shapiro-Wilk 5% Critical Value	0.93
Log-transformed Statistics		Data not lognormal at 5% significance level	
Minimum of log data	1.36		
Maximum of log data	5.36	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	2.75	95% H-UCL	31.35
Standard Deviation of log data	0.85	95% Chebyshev (MVUE) UCL	37.98
Variance of log data	0.73	97.5% Chebyshev (MVUE) UCL	44.84
		99% Chebyshev (MVUE) UCL	58.31
		95% Non-parametric UCLs	
		CLT UCL	39.32
		Adj-CLT UCL (Adjusted for skewness)	44.13
		Mod-t UCL (Adjusted for skewness)	40.44
		Jackknife UCL	39.69
		Standard Bootstrap UCL	39.01
		Bootstrap-t UCL	60.37
RECOMMENDATION		Hall's Bootstrap UCL	46.04
Data are Non-parametric (0.05)		Percentile Bootstrap UCL	39.92
		BCA Bootstrap UCL	45.90
Use 95% Chebyshev (Mean, Sd) UCL		**95% Chebyshev (Mean, Sd) UCL**	**60.12**
		97.5% Chebyshev (Mean, Sd) UCL	74.56
		99% Chebyshev (Mean, Sd) UCL	102.94

Data File

Variable: **Trespasser Sediment**

Raw Statistics	
Number of Valid Samples	9
Number of Unique Samples	9
Minimum	96
Maximum	2300
Mean	649.11
Median	310
Standard Deviation	728.15
Variance	530204
Coefficient of Variation	1.12
Skewness	1.71

Gamma Statistics	
k hat	1.05
k star (bias corrected)	0.77
Theta hat	618.57
Theta star	839.01
nu hat	18.89
nu star	13.93
Approx.Chi Square Value (.05)	6.52
Adjusted Level of Significance	0.02
Adjusted Chi Square Value	5.49

Log-transformed Statistics	
Minimum of log data	4.56
Maximum of log data	7.74
Mean of log data	5.93
Standard Deviation of log data	1.12
Variance of log data	1.26

RECOMMENDATION

Data follow gamma distribution (0.05)

Use Approximate Gamma UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.78
Shapiro-Wilk 5% Critical Value	0.83
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	1100.46

Gamma Distribution Test	
A-D Test Statistic	0.43
A-D 5% Critical Value	0.74
K-S Test Statistic	0.22
K-S 5% Critical Value	0.29
Data follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	**1387**
Adjusted Gamma UCL	1647

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.9
Shapiro-Wilk 5% Critical Value	0.8
Data are lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	2917.4
95% Chebyshev (MVUE) UCL	1718.7
97.5% Chebyshev (MVUE) UCL	2186.0
99% Chebyshev (MVUE) UCL	3104.0

95% Non-parametric UCLs	
CLT UCL	1048.3
Adj-CLT UCL (Adjusted for skewness)	1196.5
Mod-t UCL (Adjusted for skewness)	1123.6
Jackknife UCL	1100.5
Standard Bootstrap UCL	1040.4
Bootstrap-t UCL	1621.2
Hall's Bootstrap UCL	2782.5
Percentile Bootstrap UCL	1067.2
BCA Bootstrap UCL	1158.6
95% Chebyshev (Mean, Sd) UCL	1707.1
97.5% Chebyshev (Mean, Sd) UCL	2164.9
99% Chebyshev (Mean, Sd) UCL	3064.1

Arlington Ave Sediment

Data File

Raw Statistics	
Number of Valid Samples	14
Number of Unique Samples	10
Minimum	9.4
Maximum	46
Mean	21.5
Median	12
Standard Deviation	14.1
Variance	198.7
Coefficient of Variation	0.7
Skewness	0.8

Gamma Statistics	
k hat	2.8
k star (bias corrected)	2.2
Theta hat	7.7
Theta star	9.6
nu hat	78.3
nu star	62.8
Approx.Chi Square Value (.05)	45.6
Adjusted Level of Significance	0.0
Adjusted Chi Square Value	43.6

Log-transformed Statistics	
Minimum of log data	2.2
Maximum of log data	3.8
Mean of log data	2.9
Standard Deviation of log data	0.6
Variance of log data	0.4

RECOMMENDATION
Data are Non-parametric (0.05)

Use 95% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.8
Shapiro-Wilk 5% Critical Value	0.9
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	28.2

Gamma Distribution Test	
A-D Test Statistic	1.3
A-D 5% Critical Value	0.7
K-S Test Statistic	0.3
K-S 5% Critical Value	0.2
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	29.7
Adjusted Gamma UCL	31.0

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.8
Shapiro-Wilk 5% Critical Value	0.9
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	32.0
95% Chebyshev (MVUE) UCL	37.5
97.5% Chebyshev (MVUE) UCL	44.5
99% Chebyshev (MVUE) UCL	58.2

95% Non-parametric UCLs	
CLT UCL	27.7
Adj-CLT UCL (Adjusted for skewness)	28.6
Mod-t UCL (Adjusted for skewness)	28.3
Jackknife UCL	28.2
Standard Bootstrap UCL	27.6
Bootstrap-t UCL	29.4
Hall's Bootstrap UCL	27.0
Percentile Bootstrap UCL	27.7
BCA Bootstrap UCL	28.6
95% Chebyshev (Mean, Sd) UCL	38.0
97.5% Chebyshev (Mean, Sd) UCL	45.1
99% Chebyshev (Mean, Sd) UCL	59.0

Railroad Ditch Sediment

Data File

Raw Statistics	
Number of Valid Samples	6
Number of Unique Samples	5
Minimum	12
Maximum	**169**
Mean	67.67
Median	24
Standard Deviation	72.98
Variance	5326.27
Coefficient of Variation	1.08
Skewness	0.97

Gamma Statistics	
k hat	1.09
k star (bias corrected)	0.66
Theta hat	62.08
Theta star	103.13
nu hat	13.08
nu star	7.87
Approx.Chi Square Value (.05)	2.66
Adjusted Level of Significance	0.01
Adjusted Chi Square Value	1.70

Log-transformed Statistics	
Minimum of log data	2.48
Maximum of log data	5.13
Mean of log data	3.69
Standard Deviation of log data	1.11
Variance of log data	1.24

RECOMMENDATION

Data are lognormal (0.05)

Use 95% Chebyshev (MVUE) UCL

Recommended UCL exceeds the maximum observation
Default to maximum observation value = 169

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.71
Shapiro-Wilk 5% Critical Value	0.788
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	127.70

Gamma Distribution Test	
A-D Test Statistic	0.81
A-D 5% Critical Value	0.71
K-S Test Statistic	0.38
K-S 5% Critical Value	0.34
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	200.2
Adjusted Gamma UCL	313.8

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.8
Shapiro-Wilk 5% Critical Value	0.8
Data are lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	769.3
95% Chebyshev (MVUE) UCL	**190.1**
97.5% Chebyshev (MVUE) UCL	244.3
99% Chebyshev (MVUE) UCL	350.7

95% Non-parametric UCLs	
CLT UCL	116.7
Adj-CLT UCL (Adjusted for skewness)	129.3
Mod-t UCL (Adjusted for skewness)	129.7
Jackknife UCL	127.7
Standard Bootstrap UCL	112.3
Bootstrap-t UCL	688.7
Hall's Bootstrap UCL	1066.4
Percentile Bootstrap UCL	116.0
BCA Bootstrap UCL	117.8
95% Chebyshev (Mean, Sd) UCL	197.5
97.5% Chebyshev (Mean, Sd) UCL	253.7
99% Chebyshev (Mean, Sd) UCL	364.1

Appendix D

Post-Remediation Arsenic Risks

Post-Remediation Risks for Arsenic

Receptor/Exposure Pathway	Pre-Remediation Arsenic EPC (mg/kg)	Pre-Remediation Cancer Risk	Pre-Remediation Hazard Index	Post-Remediation Arsenic EPC (mg/kg)	Post-Remediation Cancer Risk	Post-Remediation Hazard Index
Onsite Construction Worker 2	123	7E-06	1	15.9	9E-07	0.1
Grassy Area Groundskeeper	779	7E-05	0.4	49.2	4E-06	0.03
Grassy Area Site Worker	779	1E-04	0.7	49.2	7E-06	0.04
Grassy Area Construction Worker 1	818	5E-05	2	24.0	1E-06	0.04
Grassy Area Construction Worker 2	818	5E-05	8	24.0	1E-06	0.2

Onsite Main Facility Area
Post-Remediation Arsenic Data Set
Construction Worker 2

Post-Remediation UCL (mg/kg)	15.9

Exposure Area	MATRIX	Station	SAMPLE ID	DEPTH	Arsenic	Lead	Samples removed for Lead Remediation	Post-remediation Arsenic Conc. (mg/kg)
Site	SOIL	CSB-10	CSB-10A-D	24-27"	2730	475000	x	5
Site	SOIL	CSB12	CSB12A	0-3"	1050	467000	x	5
Site	SOIL	CSB4	CSB4B	6-9"	164	460000	x	5
Site	SOIL	CSB12	CSB12B	6-9"	2270	372000	x	5
Site	SOIL	CSB11	CSB11B	6-9"	585	351000	x	5
Site	SOIL	CSB35	CSB-35A-C	12-15"	408	350000	x	5
Site	SOIL	CSB-10	CSB-10A-F	48-51"	1700	288000	x	5
Site	SOIL	CSB1	CSB1B	6-9"	599	268000	x	5
Site	SOIL	CSB-10	CSB-10A-C	12-15"	433	256000	x	5
Site	SOIL	CSB7	CSB7A	0-3"	81	255000	x	5
Site	SOIL	CSB1	CSB-1A-D	24-27"	989	249000	x	5
Site	SOIL	CSB-10	CSB10B	6-9"	916	236000	x	5
Site	SOIL	CSB4	CSB4A	0-3"	690	192000	x	5
Site	SOIL	CSB2	CSB2C	12-15"	469	180000	x	5
Site	SOIL	CSB2	CSB2A	0-3"	266	175000	x	5
Site	SOIL	CSB32	CSB-32A-A	0-3"	394	164000	x	5
Site	SOIL	CSB7	CSB7B	6-9"	788	154000	x	5
Site	SOIL	CSB3	CSB3B	6-9"	565	150000	x	5
Site	SOIL	CSB1	CSB1A	0-3"	406	139000	x	5
Site	SOIL	CSB-10	CSB10A	0-3"	709	132000	x	5
Site	SOIL	CSB3	CSB3A	0-3"	284	121000	x	5
Site	SOIL	CSB11	CSB11A	0-3"	237	104000	x	5
Site	SOIL	CSB34	CSB34A	0-3"	189	94500	x	5
Site	SOIL	CSB3	CSB3D	24-28"	193	93900	x	5
Site	SOIL	CSB32	CSB-32A-B	6-9"	199	90100	x	5
Site	SOIL	CSB8	CSB8A	0-3"	66	83800	x	5
Site	SOIL	RSB25	RSB25A	0-3"	867	83500	x	5
Site	SOIL	CSB3	CSB3C	12-15"	217	78100	x	5
Site	SOIL	CSB7	CSB7C	12-15"	343	77200	x	5
Site	SOIL	CSB35	CSB-35A-A	0-3"	154	70400	x	5
Site	SOIL	RSB71	RSB71A	0-3"	215	66800	x	5
Site	SOIL	CSB32	CSB-32A-C	12-15"	230	64000	x	5
Site	SOIL	CSB2	CSB2B	6-9"	159	58400	x	5
Site	SED	RSED6	RSED6A	0-6"	305	57200	x	5
Site	SOIL	CSB51	CSB51A	0-3"	265	47300	x	5
Site	SOIL	CSB39	CSB39A	0-3"	863	46800	x	5
Site	SOIL	CSB32	CSB32A	0-3"	388	42800	x	5
Site	SOIL	RSB58	RSB58A	0-3"	247	32000	x	5
Site	SOIL	RSB31	RSB31B	3-10"	232	27400	x	5
Site	SOIL	RSB55	RSB55A	0-3"	323	27400	x	5
Site	SOIL	RSB55	RSB55B	3-10"	359	27000	x	5
Site	SOIL	RSB31	RSB31A	0-3"	202	23700	x	5
Site	SOIL	RSB54	RSB54A	0-3"	107	22800	x	5
Site	SOIL	RSB58	RSB58B	3-10"	200	21000	x	5
Site	SOIL	CSB51	CSB51D	24-28"	36	18700	x	5
Site	SOIL	RSB12	RSB12B	3-10"	125	17500	x	5
Site	SOIL	RSB57	RSB57B	3-10"	127	17400	x	5
Site	SOIL	RSB54	RSB54B	3-10"	94	17300	x	5
Site	SOIL	RSB57	RSB57A	0-3"	235	17000	x	5
Site	SED	RSED6	RSED6B	6-12"	114	14800	x	5
Site	SOIL	RSB55	RSB55C	24-30"	60	13100	x	5
Site	SOIL	CSB51	CSB51E	36-39"	26	12000	x	5

Onsite Main Facility Area
Post-Remediation Arsenic Data Set
Construction Worker 2

Post-Remediation UCL (mg/kg)	15.9

Exposure Area	MATRIX	Station	SAMPLE ID	DEPTH	Arsenic	Lead	Samples removed for Lead Remediation	Post-remediation Arsenic Conc. (mg/kg)
Site	SOIL	RSB12	RSB12A	0-3"	95	11100	x	5
Site	SOIL	RSB58	RSB58C	24-30"	37	11100	x	5
Site	SOIL	CSB35	CSB35D	24-28"	12	10800	x	5
Site	SOIL	RSB77	RSB77A	0-3"	7	10700	x	5
Site	SOIL	CSB51	CSB51B	6-9"	187	10300	x	5
Site	SOIL	RSB26	RSB26A	0-3"	175	9670	x	5
Site	SOIL	RSB14	RSB14B	3-10"	15	8480	x	5
Site	SOIL	RSB26	RSB26B	3-10"	184	8130		184
Site	SOIL	RSB14	RSB14A	0-3"	24	8100		24
Site	SOIL	CSB51	CSB51F	48-51"	18	8020		18
Site	SOIL	RSB25	RSB25B	3-10"	104	7930		104
Site	SOIL	RSB73	RSB73A	0-3"	18	6710		18
Site	SOIL	CSB40	CSB40A	0-3"	39	6660		39
Site	SOIL	CSB38	CSB-38A-A	0-3"	67	6200		67
Site	SOIL	CSB51	CSB51C	12-15"	17	5680		17
Site	SOIL	CSB35	CSB35E	36-39"	15	4910		15
Site	SOIL	RSB57	RSB57C	24-30"	16	3850		16
Site	SOIL	RSB75	RSB75A	0-3"	58	3220		58
Site	SOIL	RSB28	RSB28A	0-3"	56	3140		56
Site	SOIL	CSB35	CSB35A	0-3"	8.4	3090		8.4
Site	SOIL	RSB78	RSB78A	0-3"	14	3060		14
Site	SOIL	CSB35	CSB35F	48-51"	12	3010		12
Site	SOIL	RSB78	RSB78C	24-30"	13	2960		13
Site	SOIL	RSB77	RSB77B	3-10"	7.7	2920		7.7
Site	SOIL	RSB78	RSB78B	3-10"	12	2600		12
Site	SOIL	CSB25	CSB25B	6-9"	75	2420		75
Site	SOIL	CSB30	CSB-30A-A	0-3"	30	2360		30
Site	SOIL	CSB34	CSB34B	6-9"	9.1	2360		9.1
Site	SOIL	CSB13	CSB-13A-A	0-3"	11	2300		11
Site	SOIL	CSB31	CSB31B	6-9"	22	2280		22
Site	SOIL	RSB33	RSB33A	0-3"	56	2200		56
Site	SOIL	RSB38	RSB38A	0-3"	14	2000		14
Site	SOIL	CSB-10	CSB-10A-A	0-3"	4.5	1780		4.5
Site	SOIL	CSB-10	CSB10C	12-15"	17	1500		17
Site	SOIL	RSB75	RSB75B	3-10"	15	1500		15
Site	SOIL	RSB29	RSB29A	0-3"	23	1480		23
Site	SOIL	CSB35	CSB35C	12-15"	7	1400		7
Site	SOIL	CSB-10	CSB-10A-B	6-9"	6.1	1210		6.1
Site	SOIL	CSB13	CSB-13A-B	6-9"	22	1070		22
Site	SOIL	RSB15	RSB15A	0-3"	22	1070		22
Site	SOIL	CSB8	CSB8B	6-9"	10	989		10
Site	SOIL	RSB23	RSB23A	0-3"	18	987		18
Site	SOIL	RSB75	RSB75C	24-30"	12	962		12
Site	SOIL	CSB1	CSB-1A-A	0-3"	3.2	903		3.2
Site	SOIL	CSB33	CSB33B	6-9"	12	868		12
Site	SOIL	CSB1	CSB-1A-E	36-39"	6.8	847		6.8
Site	SOIL	RSB32	RSB32A	0-3"	13	841		13
Site	SOIL	CSB32	CSB32C	12-15"	7	694		7
Site	SOIL	RSB37	RSB37A	0-3"	17	679		17
Site	SOIL	RSB76	RSB76B	3-10"	10	648		10
Site	SOIL	RSB37	RSB37B	3-10"	13	594		13
Site	SOIL	RSB20	RSB20A	0-3"	14	593		14

Onsite Main Facility Area
Post-Remediation Arsenic Data Set
Construction Worker 2

Post-Remediation UCL (mg/kg)	15.9

Exposure Area	MATRIX	Station	SAMPLE ID	DEPTH	Arsenic	Lead	Samples removed for Lead Remediation	Post-remediation Arsenic Conc. (mg/kg)
Site	SOIL	CSB26	CSB26C	12-15"	8.6	583		8.6
Site	SOIL	CSB-10	CSB10D	12-15"	6.9	548		6.9
Site	SOIL	RSB32	RSB32B	3-10"	7.7	531		7.7
Site	SOIL	RSB17	RSB17A	0-3"	10	530		10
Site	SOIL	RSB18	RSB18A	0-3"	7.8	526		7.8
Site	SOIL	CSB11	CSB11C	12-15"	14	522		14
Site	SOIL	CSB35	CSB35B	6-9"	9.5	518		9.5
Site	SOIL	CSB1	CSB1C	12-15"	8	511		8
Site	SOIL	CSB35	CSB-35A-E	36-39"	6.3	499		6.3
Site	SOIL	CSB50	CSB50A	0-3"	15	480		15
Site	SOIL	RSB22	RSB22A	0-3"	21	478		21
Site	SOIL	RSB28	RSB28B	3-10"	16	478		16
Site	SOIL	RSB38	RSB38B	3-10"	7.2	440		7.2
Site	SOIL	CSB31	CSB31A	0-3"	14	431		14
Site	SOIL	CSB25	CSB25A	0-3"	13	411		13
Site	SOIL	CSB32	CSB32B	6-9"	7.4	403		7.4
Site	SOIL	RSB74	RSB74A	0-3"	13	380		13
Site	SOIL	CSB30	CSB-30A-B	6-9"	13	366		13
Site	SOIL	CSB12	CSB12C	12-15"	14	353		14
Site	SOIL	RSB29	RSB29B	3-10"	11	350		11
Site	SOIL	CSB21	CSB21B	6-9"	9.3	329		9.3
Site	SOIL	CSB37	CSB37A	0-3"	30	325		30
Site	SOIL	CSB13	CSB13A	0-3"	38	323		38
Site	SOIL	CSB38	CSB-38A-E	36-39"	8.6	319		8.6
Site	SOIL	CSB37	CSB37B	6-9"	7.9	314		7.9
Site	SOIL	CSB9	CSB9A	0-3"	12	289		12
Site	SOIL	CSB35	CSB-35A-D	24-27"	6	285		6
Site	SOIL	CSB35	CSB-35A-B	6-9"	6.1	279		6.1
Site	SOIL	CSB8	CSB8C	12-15"	10	279		10
Site	SOIL	CSB-10	CSB-10A-E	36-39"	7.1	253		7.1
Site	SOIL	CSB33	CSB33C	12-15"	13	245		13
Site	SOIL	CSB30	CSB-30A-C	12-15"	9.1	243		9.1
Site	SOIL	CSB37	CSB37C	12-15"	6.8	242		6.8
Site	SOIL	RSB22	RSB22B	3-10"	10	237		10
Site	SOIL	CSB16	CSB16C	12-15"	7.5	234		7.5
Site	SOIL	CSB3	CSB3E	36-39"	12	232		12
Site	SOIL	RSB77	RSB77C	24-30"	6.6	232		6.6
Site	SOIL	CSB50	CSB50C	12-15"	10	229		10
Site	SOIL	RSB81	RSB81A	0-3"	9.4	229		9.4
Site	SOIL	RSB15	RSB15B	3-10"	10	211		10
Site	SOIL	CSB16	CSB16A	0-3"	6	209		6
Site	SOIL	RSB79	RSB79B	3-10"	6.9	205		6.9
Site	SOIL	CSB33	CSB33A	0-3"	13	196		13
Site	SOIL	CSB16	CSB16B	6-9"	7.2	195		7.2
Site	SOIL	CSB26	CSB26A	0-3"	7.7	191		7.7
Site	SOIL	CSB19	CSB19A	0-3"	9	187		9
Site	SOIL	RSB73	RSB73C	24-30"	7.6	178		7.6
Site	SOIL	RSB74	RSB74B	3-10"	9	177		9
Site	SOIL	CSB-26	CSB-26A-A	0-3"	12	174		12
Site	SOIL	CSB1	CSB-1A-F	48-51"	8.5	170		8.5
Site	SOIL	CSB6	CSB6A	0-3"	8.9	165		8.9
Site	SOIL	RSB79	RSB79C	24-30"	8.1	164		8.1

Onsite Main Facility Area
Post-Remediation Arsenic Data Set
Construction Worker 2

Post-Remediation UCL (mg/kg)	15.9

Exposure Area	MATRIX	Station	SAMPLE ID	DEPTH	Arsenic	Lead	Samples removed for Lead Remediation	Post-remediation Arsenic Conc. (mg/kg)
Site	SOIL	RSB23	RSB23B	3-10"	2.6	157		2.6
Site	SOIL	RSB54	RSB54C	24-30"	3.4	151		3.4
Site	SOIL	CSB49	CSB49A	0-3"	8.1	147		8.1
Site	SOIL	RSB73	RSB73B	3-10"	11	145		11
Site	SOIL	CSB9	CSB9B	6-9"	11	132		11
Site	SOIL	CSB50	CSB50B	6-9"	13	131		13
Site	SOIL	CSB19	CSB19C	12-15"	6.7	129		6.7
Site	SOIL	CSB5	CSB5A	0-3"	7.2	125		7.2
Site	SOIL	CSB7	CSB7D	24-28"	6.9	114		6.9
Site	SOIL	CSB25	CSB25C	12-15"	8.8	108		8.8
Site	SOIL	CSB36	CSB36A	0-3"	170	103		170
Site	SOIL	CSB17	CSB17C	12-15"	6.9	101		6.9
Site	SOIL	RSB20	RSB20B	3-10"	10	97		10
Site	SOIL	CSB15	CSB15B	6-9"	7.8	89		7.8
Site	SOIL	CSB-26	CSB-26A-B	6-9"	11	88		11
Site	SOIL	RSB56	RSB56C	24-30"	6.1	88		6.1
Site	SOIL	CSB17	CSB17A	0-3"	7.3	87		7.3
Site	SOIL	RSB80	RSB80A	0-3"	7.4	85		7.4
Site	SOIL	CSB19	CSB19B	6-9"	6.8	79		6.8
Site	SOIL	RSB52	RSB52B	3-10"	5.9	77		5.9
Site	SOIL	CSB36	CSB36B	6-9"	15	76		15
Site	SOIL	CSB13	CSB-13A-C	12-15"	6.6	75		6.6
Site	SOIL	RSB74	RSB74C	24-30"	4.9	75		4.9
Site	SOIL	CSB26	CSB26B	6-9"	6.5	73		6.5
Site	SOIL	RSB76	RSB76C	24-30"	7.7	72		7.7
Site	SOIL	CSB18	CSB18A	0-3"	7.8	70		7.8
Site	SOIL	CSB35	CSB-35A-F	48-51"	6.3	69		6.3
Site	SOIL	CSB39	CSB39B	6-9"	8	69		8
Site	SOIL	CSB6	CSB6C	12-15"	11	69		11
Site	SOIL	CSB34	CSB34C	12-15"	7	68		7
Site	SOIL	CSB36	CSB36C	12-15"	12	67		12
Site	SOIL	CSB5	CSB5B	6-9"	7.1	67		7.1
Site	SOIL	RSB52	RSB52C	24-30"	6.9	67		6.9
Site	SOIL	CSB4	CSB4C	12-15"	6.8	65		6.8
Site	SOIL	RSB79	RSB79A	0-3"	8.5	57		8.5
Site	SOIL	CSB9	CSB9C	12-15"	7.7	53		7.7
Site	SOIL	CSB6	CSB6B	6-9"	9.6	50		9.6
Site	SOIL	RSB18	RSB18B	3-10"	6.3	50		6.3
Site	SOIL	CSB13	CSB13C	12-15"	10	49		10
Site	SOIL	CSB41	CSB41A	0-3"	4.8	45		4.8
Site	SOIL	CSB1	CSB-1A-C	12-15"	1.5	44		1.5
Site	SOIL	CSB29	CSB29B	6-9"	25	44		25
Site	SOIL	CSB5	CSB5C	12-15"	5.1	42		5.1
Site	SOIL	CSB-26	CSB-26A-C	12-15"	6.4	40		6.4
Site	SOIL	CSB32	CSB-32A-D	24-27"	8	40		8
Site	SOIL	CSB13	CSB-13A-D	24-27"	5.9	39		5.9
Site	SOIL	CSB18	CSB18C	12-15"	8.3	38		8.3
Site	SOIL	RSB82	RSB82B	3-10"	24	37		24
Site	SOIL	CSB29	CSB29C	12-15"	11	36		11
Site	SOIL	RSB72	RSB72A	0-3"	8.7	34		8.7
Site	SOIL	CSB21	CSB21C	12-15"	6.8	32		6.8
Site	SOIL	CSB23	CSB23C	12-15"	6.2	32		6.2

Onsite Main Facility Area
Post-Remediation Arsenic Data Set
Construction Worker 2

Post-Remediation UCL (mg/kg)	15.9

Exposure Area	MATRIX	Station	SAMPLE ID	DEPTH	Arsenic	Lead	Samples removed for Lead Remediation	Post-remediation Arsenic Conc. (mg/kg)
Site	SOIL	CSB29	CSB29A	0-3"	9.2	32		9.2
Site	SOIL	CSB30	CSB-30A-D	24-27"	6.6	32		6.6
Site	SOIL	CSB21	CSB21A	0-3"	7.8	31		7.8
Site	SOIL	RSB83	RSB83C	24-30"	16	31		16
Site	SOIL	CSB13	CSB13B	6-9"	11	30		11
Site	SOIL	CSB20	CSB20A	0-3"	9.6	30		9.6
Site	SOIL	CSB28	CSB-28A-A	0-3"	53	30		53
Site	SOIL	RSB56	RSB56A	0-3"	8.6	30		8.6
Site	SOIL	CSB28	CSB28C	12-15"	23	29		23
Site	SOIL	CSB14	CSB14A	0-3"	2.2	28		2.2
Site	SOIL	CSB15	CSB15C	12-15"	5.3	28		5.3
Site	SOIL	CSB24	CSB24A	0-3"	4.8	28		4.8
Site	SOIL	CSB13	CSB-13A-E	36-39"	6	27		6
Site	SOIL	CSB28	CSB-28A-C	12-15"	7.9	27		7.9
Site	SOIL	RSB56	RSB56B	3-10"	7.7	27		7.7
Site	SOIL	CSB18	CSB18B	6-9"	6	26		6
Site	SOIL	CSB-26	CSB-26A-D	24-27"	6.2	25		6.2
Site	SOIL	RSB52	RSB52A	0-3"	6.6	25		6.6
Site	SOIL	CSB20	CSB20C	12-15"	2.4	23		2.4
Site	SOIL	CSB-26	CSB-26A-E	36-39"	5.8	23		5.8
Site	SOIL	RSB80	RSB80B	3-10"	7	23		7
Site	SOIL	RSB80	RSB80C	24-30"	6.7	23		6.7
Site	SOIL	CSB27	CSB27A	0-3"	6.3	22		6.3
Site	SOIL	CSB38	CSB38A	0-3"	4.9	22		4.9
Site	SOIL	CSB38	CSB-38A-C	12-15"	9.3	22		9.3
Site	SOIL	RSB33	RSB33B	3-10"	10	22		10
Site	SOIL	RSB17	RSB17B	3-10"	9.7	21		9.7
Site	SOIL	RSB53	RSB53A	0-3"	8.2	21		8.2
Site	SOIL	RSB84	RSB84B	3-10"	15	21		15
Site	SOIL	CSB17	CSB17B	6-9"	7.1	20		7.1
Site	SOIL	CSB24	CSB24B	6-9"	9.3	20		9.3
Site	SOIL	CSB32	CSB-32A-E	36-39"	6.5	20		6.5
Site	SOIL	CSB40	CSB40B	6-9"	6.4	20		6.4
Site	SOIL	CSB20	CSB20B	6-9"	6.9	19		6.9
Site	SOIL	CSB28	CSB28B	6-9"	10	19		10
Site	SOIL	CSB38	CSB38C	12-15"	7.8	19		7.8
Site	SOIL	CSB7	CSB7E	36-39"	6.2	19		6.2
Site	SOIL	RSB34	RSB34A	0-3"	6.5	19		6.5
Site	SOIL	RSB34	RSB34B	3-10"	6.3	19		6.3
Site	SOIL	CSB1	CSB-1A-B	6-9"	1.5	18		1.5
Site	SOIL	CSB14	CSB14C	12-15"	6.4	18		6.4
Site	SOIL	CSB49	CSB49B	6-9"	6.4	18		6.4
Site	SOIL	RSB53	RSB53B	3-10"	8.3	18		8.3
Site	SOIL	RSB81	RSB81B	3-10"	9.3	18		9.3
Site	SOIL	CSB49	CSB49C	12-15"	6.8	17		6.8
Site	SOIL	RSB53	RSB53C	24-30"	6.9	17		6.9
Site	SOIL	RSB83	RSB83A	0-3"	9.9	17		9.9
Site	SOIL	CSB28	CSB-28A-E	36-39"	9.4	16		9.4
Site	SOIL	CSB30	CSB30A	0-3"	9.5	16		9.5
Site	SOIL	RSB82	RSB82A	0-3"	8.5	16		8.5
Site	SOIL	RSB82	RSB82C	24-30"	9.3	16		9.3
Site	SOIL	RSB84	RSB84A	0-3"	10	16		10

Onsite Main Facility Area
Post-Remediation Arsenic Data Set
Construction Worker 2

Post-Remediation UCL (mg/kg)	15.9

Exposure Area	MATRIX	Station	SAMPLE ID	DEPTH	Arsenic	Lead	Samples removed for Lead Remediation	Post-remediation Arsenic Conc. (mg/kg)
Site	SOIL	CSB30	CSB30C	12-15"	11	15		11
Site	SOIL	CSB38	CSB38B	6-9"	4.4	15		4.4
Site	SOIL	CSB39	CSB39C	12-15"	5.8	15		5.8
Site	SOIL	CSB42	CSB42C	12-15"	7.8	15		7.8
Site	SOIL	RSB72	RSB72B	3-10"	7	15		7
Site	SOIL	RSB72	RSB72C	24-30"	8.2	15		8.2
Site	SOIL	CSB27	CSB27C	12-15"	6.4	14		6.4
Site	SOIL	CSB28	CSB28A	0-3"	4.4	14		4.4
Site	SOIL	CSB28	CSB-28A-D	24-27"	6.5	14		6.5
Site	SOIL	CSB38	CSB-38A-B	6-9"	7.9	14		7.9
Site	SOIL	CSB40	CSB40C	12-15"	11	14		11
Site	SOIL	RSB27	RSB27A	0-3"	8.1	14		8.1
Site	SOIL	RSB27	RSB27B	3-10"	6.5	14		6.5
Site	SOIL	CSB27	CSB27B	6-9"	8.5	13		8.5
Site	SOIL	CSB28	CSB-28A-B	6-9"	5.1	13		5.1
Site	SOIL	CSB30	CSB-30A-E	36-39"	6.6	13		6.6
Site	SOIL	CSB30	CSB30B	6-9"	6.7	13		6.7
Site	SOIL	RSB19	RSB19B	3-10"	6.8	13		6.8
Site	SOIL	CSB24	CSB24C	12-15"	4.4	12		4.4
Site	SOIL	CSB38	CSB-38A-D	24-27"	2.5	12		2.5
Site	SOIL	RSB84	RSB84C	24-30"	5.7	12		5.7
Site	SOIL	CSB23	CSB23B	6-9"	7	11		7
Site	SOIL	CSB42	CSB42A	0-3"	23	11		23
Site	SOIL	CSB42	CSB42B	6-9"	73	11		73
Site	SOIL	RSB19	RSB19A	0-3"	7	11		7
Site	SOIL	RSB81	RSB81C	24-30"	7	11		7
Site	SOIL	RSB83	RSB83B	3-10"	7.4	11		7.4
Site	SOIL	CSB23	CSB23A	0-3"	7.5	10		7.5
Site	SOIL	CSB31	CSB31C	12-15"	6.7	10		6.7
Site	SOIL	CSB14	CSB14B	6-9"	5.7	9.8		5.7
Site	SOIL	CSB22	CSB22C	12-15"	6.6	9.8		6.6
Site	SOIL	CSB15	CSB15A	0-3"	7	9.6		7
Site	SOIL	RSB85	RSB85A	0-3"	7.1	9.1		7.1
Site	SOIL	CSB41	CSB41B	6-9"	7.6	8.9		7.6
Site	SOIL	CSB41	CSB41C	12-15"	6.3	8.8		6.3
Site	SOIL	RSB85	RSB85C	24-30"	7	8.7		7
Site	SOIL	RSB85	RSB85B	3-10"	6.7	8.2		6.7
Site	SOIL	CSB22	CSB22A	0-3"	6.3	8		6.3
Site	SOIL	CSB22	CSB22B	6-9"	6.7	7.7		6.7
Site	SOIL	RSB76	RSB76A	0-3"	24	4.7		24

Grassy Area Soil and Sediment combined (0-6")
Post-Remediation Arsenic Data Set
Groundskeeper and Site Worker

Post-Remediation UCL (mg/kg)	49.2

MATRIX	DEPTH	Station	As Conc (mg/kg)	Samples removed for Lead Remediation	Post-remediation Arsenic Conc. (mg/kg)
SED	0-6"	RSED1	310	x	5
SED	0-6"	RSED2	713	x	5
SED	0-6"	RSED3	740	x	5
SED	0-6"	RSED4	2300	x	5
SED	0-6"	RSED5	1230	x	5
SED	0-6"	RSED7	170	x	5
SED	0-6"	RSED8	159	x	5
SED	0-6"	RSED9	124	x	5
SED	0-6"	RSED10	96	x	5
SOIL	0-3"	BSB1	5.5		5.5
SOIL	0-3"	BSB2	13		13
SOIL	0-3"	BSB3	7		7
SOIL	0-3"	BSB4	16		16
SOIL	0-3"	RSB1	11		11
SOIL	0-3"	RSB10	14		14
SOIL	0-3"	RSB11	13		13
SOIL	0-3"	RSB13	11		11
SOIL	0-3"	RSB16	13		13
SOIL	0-3"	RSB2	14		14
SOIL	0-3"	RSB21	8.3		8.3
SOIL	0-3"	RSB24	20		20
SOIL	0-3"	RSB3	9.1		9.1
SOIL	0-3"	RSB30	15		15
SOIL	0-3"	RSB35	10		10
SOIL	0-3"	RSB36	9.2		9.2
SOIL	0-3"	RSB39	10		10
SOIL	0-3"	RSB4	22		22
SOIL	0-3"	RSB40	19		19
SOIL	0-3"	RSB41	10		10
SOIL	0-3"	RSB42	15		15
SOIL	0-3"	RSB43	20		20
SOIL	0-3"	RSB44	9.5		9.5
SOIL	0-3"	RSB45	6.1		6.1
SOIL	0-3"	RSB46	3.9		3.9
SOIL	0-3"	RSB49	20		20
SOIL	0-3"	RSB5	10		10
SOIL	0-3"	RSB50	38		38
SOIL	0-3"	RSB51	169		169
SOIL	0-3"	RSB6	22		22
SOIL	0-3"	RSB7	14		14
SOIL	0-3"	RSB-70	212		212
SOIL	0-3"	RSB8	23		23
SOIL	0-3"	RSB9	96		96

Grassy Area Soil (0 - 30")
Post-Remediation Arsenic Data Set
Construction Worker 1 and 2

Post-Remediation UCL (mg/kg)	24.0

MATRIX	Station	DEPTH	Arsenic	Samples removed for Lead Remediation	Post-remediation Arsenic Conc. (mg/kg)
SED	RSED4	0-6"	2300	x	5
SED	RSED5	0-6"	1230	x	5
SED	RSED5	6-12"	3880	x	5
SED	RSED3	0-6"	740	x	5
SED	RSED2	0-6"	713	x	5
SED	RSED7	0-6"	170	x	5
SED	RSED8	0-6"	159	x	5
SED	RSED9	0-6"	124	x	5
SED	RSED1	6-12"	263	x	5
SED	RSED10	0-6"	96	x	5
SED	RSED8	6-12"	103	x	5
SED	RSED7	6-12"	78	x	5
SED	RSED1	0-6"	310	x	5
SED	RSED4	6-12"	531	x	5
SED	RSED10	6-12"	61	x	5
SED	RSED9	6-12"	50	x	5
SOIL	RSB9	0-3"	96	x	5
SOIL	RSB-70	3-10"	323	x	5
SOIL	RSB51	0-3"	169	x	5
SED	RSED3	6-12"	184	x	5
SOIL	RSB-70	0-3"	212	x	5
SOIL	RSB50	0-3"	38	x	5
SOIL	RSB51	3-10"	77		77
SED	RSED2	6-12"	229		229
SOIL	RSB9	3-10"	27		27
SOIL	RSB51	24-30"	43		43
SOIL	RSB4	0-3"	22		22
SOIL	RSB24	0-3"	20		20
SOIL	RSB6	0-3"	22		22
SOIL	RSB10	0-3"	14		14
SOIL	BSB2	0-3"	13		13
SOIL	RSB7	0-3"	14		14
SOIL	RSB43	0-3"	20		20
SOIL	RSB2	0-3"	14		14
SOIL	BSB4	0-3"	16		16
SOIL	RSB49	0-3"	20		20
SOIL	RSB8	0-3"	23		23
SOIL	RSB5	0-3"	10		10
SOIL	RSB40	0-3"	19		19
SOIL	RSB50	3-10"	9		9
SOIL	RSB30	0-3"	15		15
SOIL	RSB1	0-3"	11		11
SOIL	RSB50	24-30"	12		12
SOIL	RSB42	0-3"	15		15
SOIL	BSB4	3-10"	12		12
SOIL	RSB4	3-10"	9.8		9.8
SOIL	RSB13	0-3"	11		11
SOIL	RSB49	3-10"	1.4		1.4
SOIL	RSB16	0-3"	13		13
SOIL	RSB11	0-3"	13		13
SOIL	RSB3	0-3"	9.1		9.1
SOIL	RSB3	3-10"	7		7
SOIL	RSB21	0-3"	8.3		8.3

Grassy Area Soil (0 - 30")
Post-Remediation Arsenic Data Set
Construction Worker 1 and 2

Post-Remediation UCL (mg/kg)	24.0

MATRIX	Station	DEPTH	Arsenic	Samples removed for Lead Remediation	Post-remediation Arsenic Conc. (mg/kg)
SOIL	RSB45	0-3"	6.1		6.1
SOIL	RSB46	0-3"	3.9		3.9
SOIL	RSB44	0-3"	9.5		9.5
SOIL	RSB5	3-10"	7.5		7.5
SOIL	RSB41	0-3"	10		10
SOIL	RSB8	3-10"	9.1		9.1
SOIL	RSB6	3-10"	9		9
SOIL	RSB24	3-10"	6.5		6.5
SOIL	BSB1	24-30"	10		10
SOIL	BSB3	0-3"	7		7
SOIL	RSB10	3-10"	6.6		6.6
SOIL	RSB45	3-10"	10		10
SOIL	RSB7	3-10"	6.8		6.8
SOIL	RSB43	3-10"	11		11
SOIL	RSB39	0-3"	10		10
SOIL	RSB36	0-3"	9.2		9.2
SOIL	RSB46	3-10"	5.4		5.4
SOIL	RSB1	3-10"	6.2		6.2
SOIL	RSB42	3-10"	7.3		7.3
SOIL	RSB2	3-10"	6.6		6.6
SOIL	RSB40	3-10"	7		7
SOIL	BSB1	0-3"	5.5		5.5
SOIL	RSB30	3-10"	7.4		7.4
SOIL	RSB21	3-10"	7.2		7.2
SOIL	RSB11	3-10"	5.1		5.1
SOIL	RSB13	3-10"	5		5
SOIL	RSB16	3-10"	5.6		5.6
SOIL	RSB41	3-10"	5.7		5.7
SOIL	RSB39	3-10"	7.6		7.6
SOIL	BSB2	3-10"	5.1		5.1
SOIL	BSB1	3-10"	5.9		5.9
SOIL	RSB36	3-10"	5.7		5.7
SOIL	RSB44	3-10"	8.9		8.9
SOIL	RSB35	0-3"	10		10
SOIL	RSB35	3-10"	6.4		6.4
SOIL	BSB3	3-10"	5.4		5.4
SOIL	RSB-70	24-30"	5.5		5.5

Onsite Main Facility Area
Post-Remediation Arsenic UCL

Raw Statistics	
Number of Valid Samples	300.00
Number of Unique Samples	82.00
Minimum	1.50
Maximum	184.00
Mean	11.43
Median	7.10
Standard Deviation	17.57
Variance	308.86
Coefficient of Variation	1.54
Skewness	6.80

Gamma Statistics	
k hat	1.72
k star (bias corrected)	1.71
Theta hat	6.64
Theta star	6.70
nu hat	1033.10
nu star	1024.10
Approx.Chi Square Value (.05)	950.80
Adjusted Level of Significance	0.05
Adjusted Chi Square Value	950.46

Log-transformed Statistics	
Minimum of log data	0.41
Maximum of log data	5.21
Mean of log data	2.12
Standard Deviation of log data	0.64
Variance of log data	0.41

RECOMMENDATION
Data are Non-parametric (0.05)

Use 95% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Lilliefors Test Statisitic	0.317927
Lilliefors 5% Critical Value	0.051153
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	13.10314

Gamma Distribution Test	
A-D Test Statistic	26.26617
A-D 5% Critical Value	0.769287
K-S Test Statistic	0.225085
K-S 5% Critical Value	0.052932
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	12.31013
Adjusted Gamma UCL	12.31448

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.159646
Lilliefors 5% Critical Value	0.051153
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	10.93425
95% Chebyshev (MVUE) UCL	11.99267
97.5% Chebyshev (MVUE) UCL	12.76967
99% Chebyshev (MVUE) UCL	14.29592

95% Non-parametric UCLs	
CLT UCL	13.09796
Adj-CLT UCL (Adjusted for skewness)	13.52381
Mod-t UCL (Adjusted for skewness)	13.16957
Jackknife UCL	13.10314
Standard Bootstrap UCL	13.08214
Bootstrap-t UCL	13.95347
Hall's Bootstrap UCL	14.18564
Percentile Bootstrap UCL	13.233
BCA Bootstrap UCL	13.72167
95% Chebyshev (Mean, Sd) UCL	15.85
97.5% Chebyshev (Mean, Sd) UCL	17.76551
99% Chebyshev (Mean, Sd) UCL	21.52468

Grassy Area Soil and Sediment combined (0-6")
Post-Remediation Arsenic UCL

Raw Statistics	
Number of Valid Samples	43.0
Number of Unique Samples	23.0
Minimum	3.9
Maximum	212.0
Mean	22.2
Median	11.0
Standard Deviation	40.6
Variance	1647.7
Coefficient of Variation	1.8
Skewness	3.9

Gamma Statistics	
k hat	1.0
k star (bias corrected)	0.9
Theta hat	22.7
Theta star	23.9
nu hat	84.2
nu star	79.7
Approx.Chi Square Value (.05)	60.1
Adjusted Level of Significance	0.0
Adjusted Chi Square Value	59.5

Log-transformed Statistics	
Minimum of log data	1.4
Maximum of log data	5.4
Mean of log data	2.5
Standard Deviation of log data	0.9
Variance of log data	0.8

RECOMMENDATION
Data are Non-parametric (0.05)

Use 95% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.429
Shapiro-Wilk 5% Critical Value	0.943
Data not normal at 5% significance level	
95% UCL (Assuming Normal Distribution)	
Student's-t UCL	32.59
Gamma Distribution Test	
A-D Test Statistic	4.347
A-D 5% Critical Value	0.779
K-S Test Statistic	0.26
K-S 5% Critical Value	0.139
Data do not follow gamma distribution at 5% significance level	
95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	29.4
Adjusted Gamma UCL	29.69
Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.85
Shapiro-Wilk 5% Critical Value	0.943
Data not lognormal at 5% significance level	
95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	24.83
95% Chebyshev (MVUE) UCL	30.18
97.5% Chebyshev (MVUE) UCL	35.44
99% Chebyshev (MVUE) UCL	45.78
95% Non-parametric UCLs	
CLT UCL	32.36
Adj-CLT UCL (Adjusted for skewness)	36.25
Mod-t UCL (Adjusted for skewness)	33.19
Jackknife UCL	32.59
Standard Bootstrap UCL	32.52
Bootstrap-t UCL	50.34
Hall's Bootstrap UCL	39.99
Percentile Bootstrap UCL	33.48
BCA Bootstrap UCL	37.04
95% Chebyshev (Mean, Sd) UCL	49.16
97.5% Chebyshev (Mean, Sd) UCL	60.83
99% Chebyshev (Mean, Sd) UCL	83.77

Grassy Area Soil (0 - 30")
Post-Remediation Arsenic UCL

Raw Statistics		Normal Distribution Test
Number of Valid Samples	90	Lilliefors Test Statisitic
Number of Unique Samples	43	Lilliefors 5% Critical Value
Minimum	1.4	Data not normal at 5% significance level
Maximum	229	
Mean	12.5	95% UCL (Assuming Normal Distrit
Median	7.1	Student's-t UCL
Standard Deviation	24.9	
Variance	621.5	Gamma Distribution Test
Coefficient of Variation	2.0	A-D Test Statistic
Skewness	7.7	A-D 5% Critical Value
		K-S Test Statistic
Gamma Statistics		K-S 5% Critical Value
k hat	1.4	Data do not follow gamma distribution
k star (bias corrected)	1.4	at 5% significance level
Theta hat	8.8	
Theta star	9.0	95% UCLs (Assuming Gamma Distribu
nu hat	256.9	Approximate Gamma UCL
nu star	249.7	Adjusted Gamma UCL
Approx.Chi Square Value (.05)	214.1	
Adjusted Level of Significance	0.0	Lognormal Distribution Test
Adjusted Chi Square Value	213.6	Lilliefors Test Statisitic
		Lilliefors 5% Critical Value
Log-transformed Statistics		Data not lognormal at 5% significance le
Minimum of log data	0.3	
Maximum of log data	5.4	95% UCLs (Assuming Lognormal Dis
Mean of log data	2.1	95% H-UCL
Standard Deviation of log data	0.7	95% Chebyshev (MVUE) UCL
Variance of log data	0.5	97.5% Chebyshev (MVUE) UCL
		99% Chebyshev (MVUE) UCL
		95% Non-parametric UCLs
		CLT UCL
		Adj-CLT UCL (Adjusted for skewness)
		Mod-t UCL (Adjusted for skewness)
		Jackknife UCL
		Standard Bootstrap UCL
		Bootstrap-t UCL
RECOMMENDATION		Hall's Bootstrap UCL
Data are Non-parametric (0.05)		Percentile Bootstrap UCL
		BCA Bootstrap UCL
Use 95% Chebyshev (Mean, Sd) UCL		**95% Chebyshev (Mean, Sd) UCL**
		97.5% Chebyshev (Mean, Sd) UCL
		99% Chebyshev (Mean, Sd) UCL

Appendix E

NHANES 2000 Blood Lead Data

NHANES 2000 Blood Lead Data

The NHANES blood lead data for 1999-2000 were downloaded from the following website:

http://www.cdc.gov/nchs/about/major/nhanes/nhanes99_00.htm

The blood lead data are in the file: "Lab 06 Nutritional Biochemistries".
The demographic data are in the file: "Demographics".
The demographic and blood lead data were merged on the variable "SEQN".

Attached are the following documents:

- The SAS Code used to calculate the blood lead summary statistics from NHANES-2000
- The SAS output with the blood lead summary statistics
- Pages from the CDC NHANES-2000 Website

```
*========================================
Analyze blood lead data from NHANES-2000.
*========================================;

libname Datapath   'F:\Programs\RISK\NHANES\NHANES-2000\SD2 files';
        *path to read in data set;

libname Savepath   'F:\Programs\RISK\NHANES\NHANES-2000';
        *path to save permanent SAS data set;

*======================================================================
VARIABLE DEFINITIONS
*======================================================================

Sample number: SEQN
sex: RIAGENDR (1=male, 2=female)
age_yr: RIDAGEYR
age_mon: RIDAGEMN
exam weight: WTMEC2YR  Full Sample 2 Year Mec Exam Weight
interview weight:  WTINT2YR  Full Sample 2 Year Interview Weight


*==============================================
Perform blood lead statistics.
*==============================================;

Data Working; Set Datapath.Lab06d;


     *Define age groups;
        if      19 <= age_yr < 50       then age_grp = '19-49'   ;
        if      0 < age_yr < 7          then age_grp = '0-6'     ;
        if      7 <= age_yr < 13        then age_grp = '7-12'    ;
        if      13 <= age_yr < 19       then age_grp = '13-18'   ;
        if      50 <= age_yr            then age_grp = '50+'     ;

run;

Data Working; Set Working;

        PROC means VARDEF=weight noPrint;
                var PbB log_PbB;
                class age_grp gender ;
                weight WTMEC2YR;
                output out = Results
                       N = N log_N
                       mean = mean log_GM
                       std = SD log_GSD;
                title 'NHANES-2000 PbB Stats';
        run;


Data Results; set Results;

        GM = exp(log_GM);
        GSD = exp(log_GSD);

        PROC print;
                var age_grp gender N mean SD GM GSD;
        run;
```

SAS Output

NHANES-2000 PbB Stats   16:02 Thursday, March 24, 2005   1

OBS	AGE_GRP	GENDER	N	MEAN	SD	GM	GSD
1			7970	2.09853	2.07540	1.65531	1.93286
2		female	4057	1.70116	1.44955	1.37220	1.88815
3		male	3913	2.51036	2.50208	2.01050	1.86943
4	0-6		862	2.67822	2.46752	2.12546	1.91423
5	13-18		1595	1.27326	0.95252	1.06667	1.78400
6	19-49		2408	1.87129	1.81359	1.49421	1.88889
7	50+		2046	2.73395	2.51335	2.25231	1.80717
8	7-12		1059	1.77539	1.79584	1.44321	1.82163
9	0-6	female	385	2.82480	2.32853	2.23381	1.93548
10	0-6	male	477	2.55869	2.56914	2.04100	1.89139
11	13-18	female	788	0.99169	0.59784	0.86798	1.67908
12	13-18	male	807	1.55128	1.13785	1.30746	1.75652
13	19-49	female	1324	1.37407	1.00448	1.15761	1.76878
14	19-49	male	1084	2.39029	2.26752	1.95038	1.80418
15	50+	female	1042	2.24692	1.46971	1.92010	1.74077
16	50+	male	1004	3.30157	3.25008	2.71270	1.78529
17	7-12	female	518	1.67485	2.18416	1.32850	1.83900
18	7-12	male	541	1.86365	1.36074	1.55204	1.78897

CDC

nchs National Center for Health Statistics

Monitoring the Nation's Health

National Center for Health Statistics
3311 Toledo Road
Hyattsville, MD 20782
(301) 458-4000
Toll Free Data Inquiries
6-441-NCHS

nhanes National Health and Nutrition Examination Survey

NHANES 1999-2000 Data Files

Data, Docs, Codebooks, SAS Code

Index

Release Notes

NCHS releases public use data sets from the continuous NHANES in two year groupings (cycles). This release does not contain all of the data collected on persons who participated in the survey during those two years (9,965 persons). As more data becomes available it will be released on this webpage. These updates will be documented on this site. Data processing, methodologic and disclosure concerns are examples of the reasons why various data components from NHANES 1999-2000 are not on this first public use data release. When (and if) these concerns are resolved, the data will be made publicly available.

For a number of reasons, the release of data from the current

NHANES will not be comparable to the approach used in previous NHANES studies. The data and documentation for the interview, laboratory and examination components of the survey will be released in numerous files to facilitate ease of use and access via the Internet. This will require the user to merge files to create analytic data sets. In addition, changes in the survey design and implementation necessitate analytic guidelines that differ from previous NHANES. Many of the past general analytic principles still apply, but with adjustments for the new survey design and taking into account more recent statistical practices and procedures. The guidelines will be revised on various occasions as new issues are raised and addressed by NCHS staff. Users are encouraged to regularly check this site for updates on available data, documentation and guidelines for use of the data.

NHANES data in this release are in SAS transport file format. To access this data in any version of SAS, use the XPORT engine. It is recommended that you copy the transport files to a permanent SAS library. For example, assuming you have downloaded the Body Measures exam data to the folder "C:\NHANES", you can use the following SAS code to copy the Body Measures Exam Data:

```
LIBNAME XP XPORT "C:\NHANES\BMX.XPT";
PROC COPY IN=XP OUT=SASUSER;
RUN;
```

NHANES documentation and codebooks are in Adobe Acrobat PDF. If you do not have a current version of Acrobat Reader, a free copy may be obtained from the **Adobe web site**.

- **Demographics File** (NOTE: Clicking on the hyperlinks below will ftp self-extracting zip files. The zip files include the SAS transport file, codebook and documentation listed after each hyperlink.)
- **Demographics Variable List** (Updated July, 2004)
- **Demographics [*Codebook, Doc, Freqs, Data*]** (Updated July, 2004)

- **Examination Files** (NOTE: Clicking on the hyperlinks below will ftp self-extracting zip files. The zip files include the SAS transport file, codebook and documentation listed after each hyperlink. You can also download the codebook, documentation, frequencies or dataset for a particular examination component independently. The independent files are not zip files.)
- **General Documentation on Examination Data**
- **Variable List, SAS Code Example**
- **Audiometry [Subsample]** (Updated March 2005)
- **Balance [Subsample]** (Updated March 2005)
- **Bioelectrical Impedance Analysis [*Codebook, Doc, Freqs, Data*]**
- **Blood Pressure [*Codebook, Doc, Freqs, Data*]**
- **Body Measures [*Codebook, Doc, Freqs, Data*]**

- Cardiovascular Fitness [*Codebook, Doc, Freqs, Data*]
- Composite International Diagnostic Interview (Generalized Anxiety Disorder) [Subsample] (Updated March 2005)
- Composite International Diagnostic Interview (Major Depression Module) [Subsample] (Updated March 2005)
- Composite International Diagnostic (Interview Panic Disorder Module) [Subsample] (Updated March 2005)
- Dietary Interview (Individual Foods File) [*Codebook, Doc, Freqs, Formats, Format Doc, Data)* (Updated May, 2004)
- Dietary Interview (Total Nutrients) [*Codebook, Doc, Freqs, Data]* (Updated May 2004)
- Lower Extremity Disease (Ankle Brachial Blood Pressure Index) [*Codebook, Doc, Freqs, Data*]
- Lower Extremity Disease (Peripheral Neuropathy) [*Codebook, Doc, Freqs, Data*]
- Muscular Strength [*Codebook, Doc, Freqs, Data*]
- Oral Health (Dentition Section) [*Codebook, Doc, Freqs, Data]*
- Oral Health (Periodontal Section) [*Codebook, Doc, Freqs, Data]*
- Oral Health (Recommendation of Care/Referral Section [*Codebook, Doc, Freqs, Data]*
- Shared Exclusion Questions [*Codebook, Doc, Freqs, Data*]
- Vision Exam [*Codebook, Doc, Freqs, Data*] (New)

- **Laboratory Files** (NOTE: Clicking on the hyperlinks below will ftp self-extracting zip files. The zip files include the SAS transport file, codebook and documentation listed after each hyperlink. You can also download the codebook, documentation, frequencies or dataset for a particular examination component independently. The independent files are not zip files.)
- General Documentation on Laboratory Data
- Variable List, SAS Code Example, Sudan Code Example (Updated March, 2005)
- Laboratory Procedures Manuals (New)
- Phlebotomy [*Codebook, Doc, Freqs, Data*]
- PHPYPA Urinary Phthalates [Subsample]
- Urine Collection (Pregnancy) [*Codebook, Doc, Freqs, Data*]
- Lab 02 Hepatitis C [*Codebook, Doc, Freqs, Data]*
- Lab 03 Human Immunodeficiency Virus [*Codebook, Doc, Freqs, Data* (Updated January, 2005)
- Lab 05 Chlamydia and Gonorrhea [*Codebook, Doc, Freqs, Data*]
- Lab 06 Nutritional Biochemistries [*Codebook, Doc, Freqs, Data*] (Data File updated June, 2004) Notice to Users
- Lab 06HM Heavy Metals [Subsample] (Updated August, 2004)
- Lab 07 Latex [*Codebook, Doc, Freqs, Data*]

- **Lab 09 Herpes I & II** [*Codebook, Doc, Freqs, Data*] (Updated August, 2004)
- **Lab 10 Glycohemoglobin** [*Codebook, Doc, Freqs, Data*]
- **Lab 10AM Plasma Glucose** [Subsample] (Updated February, 2005)
- **Lab 11 C-Reactive Protein** [*Codebook, Doc, Freqs, Data*]
- **Lab 13 Total Cholesterol** [*Codebook, Doc, Freqs, Data*] (Updated September, 2003)
- **Lab 13AM Triglycerides** [Subsample] (Updated February, 2005)
- **Lab 16 Urinary Albumin and Creatinine** [*Codebook, Doc, Freqs, Data*]
- **Lab 17 Cryptosporidum and Toxoplasma** [*Codebook, Doc, Freqs, Data*]
- **Lab 18 Biochemistry Profile and Hormones** [*Codebook, Doc, Freqs, Data*] (Data File updated February, 2003)
- **Lab 18T4 Thyroid-Stimulating Hormone and Thyroxine** [Subsample] (New)
- **Lab 19 Measles, Rubella, and Varicella** [*Codebook, Doc, Freqs, Data*] (Updated January, 2005)
- **Lab 22 Hair Mercury** [*Codebook, Doc Freqs, Data*] (Updated February, 2005)
- **Lab 25 Complete Blood Count** [*Codebook, Doc, Freqs, Data*] (Updated August, 2004)
- **Lab 26 Pesticides** [Subsample]
- **Lab 28 Dioxins** [Subsample]

- **Questionnaire Files** (NOTE: Clicking on the hyperlinks below will ftp self-extracting zip files. The zip files include the SAS transport file, codebook and documentation listed after each hyperlink. You can also download the codebook, documentation, frequencies or dataset for a particular examination component independently. The independent files are not zip files.)
- **General Documentation on Questionnaire Data**
- **Variable List, SAS Code Example** (Updated March, 2005)
- **Acculturation** [*Codebook, Doc, Freqs, Data*]
- **Alcohol Use** [*Codebook, Doc, Freqs, Data*]
- **Audiometry** [*Codebook, Doc, Freqs, Data*]
- **Balance** [*Codebook, Doc, Freqs, Data*]
- **Blood Pressure** [*Codebook, Doc, Freqs, Data*]
- **Cardiovascular Disease and Health** [*Codebook, Doc, Freqs,Data*]
- **Cognitive Functioning** [*Codebook, Doc, Freqs, Data*] (New)
- **Current Health Status** [*Codebook, Doc, Freqs, Data*]
- **Dermatology** [*Codebook, Doc, Freqs, Data*]
- **Diabetes** [*Codebook, Doc, Freqs, Data*]
- **Diet Behavior & Alcohol Consumption** [*Codebook, Doc, Freqs, Data*] (Updated September, 2003)
- **Dietary Supplement Use** [*DSQ Readme, Doc,*

Data] (Updated October, 2004)

- File 1: Supplement Counts [Codebook, Freqs, Data]
- File 2: Participant's Use of Supplement [Codebook, Freqs]
- File 3: Supplement Information [Codebook, Freqs]
- File 4: Ingredient Information [Codebook, Freqs]
- File 5: Supplement Blend [Codebook, Freqs]

- Drug Use [Codebook, Doc, Freqs, Data]
- Early Childhood [Codebook, Doc, Freqs, Data]
- Family Smoking [Codebook, Doc, Freqs, Data] (New)
- Food Security [Codebook, Doc, Freqs, Data] (New)
- Health Insurance [Codebook, Doc, Freqs, Data] (New)
- Hospital Utilization [Codebook, Doc, Freqs, Data]
- Housing Characteristics [Codebook, Doc, Freqs, Data] (New)
- Immunization [Codebook, Doc, Freqs, Data]
- Kidney Conditions [Codebook, Doc, Freqs, Data]
- Medical Conditions [Codebook, Doc, Freqs, Data]
- Miscellaneous Pain [Codebook, Doc, Freqs, Data]
- Occupation [Codebook, Doc, Freqs, Data]
- Oral Health [Codebook, Doc, Freqs, Data]
- Osteoporosis [Codebook, Doc, Freqs, Data]
- Analgesics Pain Relievers [Codebook, Doc, Freqs, Data]
- Pesticide Use [Codebook, Doc, Freqs, Data] (New)
- Physical Activity [Codebook, Doc, Freqs, Data] (Revised September 2004)
- Physical Activity Individual Activities File [Codebook, Doc, Freqs, Data] (New)
- Physical Functioning [Codebook, Doc, Freqs, Data]
- Prescription Medications [Codebook, Doc, Freqs, Data]
- Reproductive Health [Codebook, Doc, Freqs, Data] (Revised September 2004)
- Respiratory Health/Disease [Codebook, Doc, Freqs, Data]
- Sexual Behavior [Codebook, Doc, Freqs, Data]
- Smoking and Tobacco Use (MEC) [Codebook, Doc, Freqs, Data]
- Smoking and Tobacco Use [Codebook, Doc, Freqs, Data] (Data File Updated February 2003)
- Social Support [Codebook, Doc, Freqs, Data]
- Tuberculosis [Codebook, Doc, Freqs, Data]
- Vision [Codebook, Doc, Freqs, Data] (New)
- Weight History [Codebook, Doc, Freqs, Data]

This page last reviewed March 28, 2005

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Center for Health Statistics
Hyattsville, MD
20782

(301) 458-4000

Section 4.2

13 SWMUs
9 AOCs
18, 20, 21, AOC 1, 4 + 5 – excavation – post ver. sam for wh

Table – 2

CORRECTIVE MEASURES STUDY REPORT
PHASE I

Prepared For:

REFINED METALS CORPORATION

Project No. 2003-1046-02
June 22, 2004
Revised October 13, 2004

Refined Metals Corporation

October 12, 2004

United States Environmental
Protection Agency – Region V
RCRA Enforcement Branch
77 W. Jackson Street, HRE-8J
Chicago, IL 60604-3590
Attn: Mr. Jonathan Adenuga

Re: Certification of Response to Comments and Revised CMS Report Phase I
Refined Metals Corporation
Beech Grove, Indiana

Dear Mr. Adenuga,

Please find enclosed Refined Metal Corporation's (Refined's) responses to EPA comments dated August 17, 2004 regarding the Corrective Measures Study Report Phase I and a revised copy of that report which incorporates EPA's comments and Refined's responses.

I certify under penalty of perjury that the information contained in or accompanying the enclosed response to comments and revised report is, to the best of my knowledge after thorough investigation, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,

REFINED METALS CORPORATION

Matt Love

Matthew A. Love

cc: Ms. Ruth Jean – IDEM
Paul G. Stratman – Advanced GeoServices Corporation

CORRECTIVE MEASURES STUDY REPORT
PHASE I

Prepared For:

REFINED METALS CORPORATION

Prepared By:

ADVANCED GEOSERVICES CORP.
West Chester, Pennsylvania

Project No. 2003-1046-02
June 22, 2004
Revised October 13, 2004

F:\OFICEAGC\PROJECTS\Files\2003-1046\Reports\CMS 10-12-04\Phase I text.doc

TABLE OF CONTENTS

ATTACHMENTS

1.0 INTRODUCTION

Presented herein, is the revised Phase I Corrective Measures Study (CMS) Report for the Refined Metals Corporation (RMC) facility in Beech Grove, Indiana. Pursuant to the CMS Work Plan, approved by USEPA in a letter dated November 5, 2003, this report has been prepared to present the results of the additional sampling activities and the preliminary risk assessment results. It has been revised to reflect the comments made by the USEPA in a letter dated August 17, 2004 on the initial version of this letter. A description of the activities is provided in the following sections. Copies of the revised CMS Activities Summary Report and revised Baseline Human Health Risk Assessment are provided as attachments.

2.0 FIELD ACTIVITIES

Based on an evaluation of previous investigation results following the Phase II RCRA Facility Investigation (RFI), a determination was made that additional characterization sampling was required for sediment and groundwater at the RMC Site. The sediment sampling consisted of collecting additional samples from the drainage ditch along the CSX Transportation railroad right-of-way north of the facility and from the grass lined drainage ditch along the west side of Arlington Avenue. Sediment samples were collected from six locations along the railroad drainage ditch and four locations in the Arlington Avenue drainage ditch. Two samples were collected at each location. Along Arlington Avenue, one sample was collected from the 0 to 6-inch depth and the second from the 6 to 12-inch depth. Along the railroad right-of-way, they were collected from 0 to 3 inches and 3 to 10 inches. The depth of the railroad samples was consistent with the requirements for soil samples, although they were intended to be consistent with the 0 to 6-inch and 6 to 12-inch depths for sediment samples. The change in depth was inadvertent and was not detected until review of sampling logs after the completion of sampling. For the metals included in the analysis, the shallower depths likely provide higher concentrations in the 0 to 3-inch and 3 to 10-inch samples when compared to a 0 to 6-inch sample or 6 to 12-inch sample, respectively, from the same location.

Groundwater sampling included the installation of three piezometers in the area north and east of the former manufacturing area. The piezometers were installed with the intent of further refining groundwater flow direction prior to selection of locations for the new monitoring wells. The piezometers were allowed to set for 24 hours before groundwater level measurements were taken from the existing shallow monitoring wells at the north end of the former manufacturing area and the piezometers. Groundwater flow direction was re-assessed based on the measurements and the locations for two new groundwater-monitoring wells were selected. The new groundwater monitoring wells were installed using hollow stem auger (HSA) drilling techniques. The piezometers were abandoned after groundwater level measurements were taken. Groundwater samples were collected from all the Site groundwater monitoring wells between October 26 and 28, 2004 using low flow sample collection techniques.

A complete description of the sediment and groundwater sampling activities is provided in the revised Phase I CMS Activities Summary Report which is provided as Attachment 1 to this report.

3.0 ANALYTICAL RESULTS

3.1 GROUNDWATER

Shallow groundwater at the Site is perched and discontinuous and is not used for any purpose. Groundwater samples collected from the shallow groundwater monitoring wells in the north end of the former manufacturing area (MW-2, 7 and 8) gave unfiltered results for total lead in excess of the Indiana Department of Environmental Management (IDEM) Residential Default RISC Criteria (15 ug/L). Analysis of filtered groundwater samples from those wells for lead from the same sampling event were at or below the IDEM Residential Default RISC Criteria. Filtered and unfiltered results for arsenic in MW-1, MW-2, MW-7 and MW-8, and unfiltered results only for MW-3, MW-5 and MW-10 were above the background concentration for arsenic (8.5 µg/l) calculated in the Phase II RFI. No other parameters for MW-2, MW-7 and MW-8 or any of the parameters analyzed for any other well on-site exceeded the IDEM Residential Default RISC Criteria.

3.2 SEDIMENT

Concentrations of lead in the shallow surface sediment samples collected at the depth of 0-3 inches ranged from 617 mg/kg to 14,800 mg/kg and concentrations or arsenic ranged from 12 mg/kg to 169 mg/kg at this depth. Concentrations of lead in the shallow surface sediment samples collected at the depth of 0-6 inches ranged from 411 mg/kg to 874 mg/kg and concentrations of arsenic ranged from 11 mg/kg to 12 mg/kg at this depth. The calculated background for arsenic in shallow surface soil (10.5 mg/kg) was exceeded in all samples. The cleanup level for lead calculated in the Human Health Risk Assessment (Attachment 2)(15,916 m/kg) was not exceeded in these samples.

Concentrations of lead in the subsurface sediment samples collected at the depth of 3-10 inches ranged from 403 mg/kg to 15,700 mg/kg and concentrations of arsenic ranged from 9 mg/kg to 216 mg/kg at this depth. Concentrations of lead in the samples collected at the depth of 6-12 inches ranged from 24 mg/kg to 1,470 mg/kg and concentrations of arsenic ranged from 8.3

mg/kg to 15 mg/kg at this depth. The calculated background concentrations for arsenic in subsurface soil (7.9 mg/kg) was exceeded in all samples. The calculated cleanup level for lead (15,916 mg/kg) was not exceeded in these samples.

4.0 PRELIMINARY RESULTS OF RISK ASSESSMENT

Gradient Corporation (Cambridge, MA) conducted the Baseline Human Health Risk Assessment (Risk Assessment) for RMC. Pursuant to the CMS Work Plan, the Risk Assessment evaluated a variety of exposure scenarios for lead and arsenic for workers at the facility and on the adjacent Citizens Gas property. The evaluation determined that the calculated risk for existing arsenic levels at the Site are within the USEPA target risk ranges for the exposure scenarios evaluated. The lead risk evaluation determined that soil lead concentrations in some areas of the Site create a predicted (95% UCL) blood lead >10ug/dl for the construction worker in the "on-site" area, and for the groundskeeper and plant worker in the "grassy area".

Results of the risk assessment for lead include a Preliminary Remediation Goal (PRG) for each of the exposure scenarios which predict a 95% UCL blood lead >10 ug/dl. The model also provides a Remedial Action Level (RAL), which represents the soil cleanup concentration that will result in remaining soil having an average soil lead concentration less than the PRG. The concept of a RAL is consistent with the adult lead model, which recognizes that the model evaluates exposure on an area wide basis. This means that soils with concentrations exceeding 78,900 mg/kg must be remediated in the "on-site" area to result in an average lead concentration less than 4,601 mg/kg. For the grassy site area (which also includes the wooded areas), the PRG and RAL are 3,195 and 16,700 mg/kg, respectively. The PRG for the Citizens Gas property is 1,840 mg/kg, which is higher than the average soil lead concentration; therefore, no remediation is necessary on the Citizens Gas property.

The complete Baseline Human Health Risk Assessment report is provided as Attachment 2.

5.0 CONCLUSION

Based on the results of the Risk Assessment, risk estimated for arsenic fall within the USEPA target risk range and the totoal hazard index are all well below 1.0. Based on this analysis, no soil remediation is believed to be necessary for arsenic.

A conclusion of the Baseline Human Health Risk Assessment is that soil remediation is necessary in the "on-site" plant area to remove subsurface soil with total lead concentrations that exceed the calculated RAL of 78,900 mg/kg. Because the exposure scenario assumes a worker who is performing intrusive activities, this standard is being applied to areas with and without pavement.

For the "grass areas", which includes all areas of the site excluding the "on-site" area, the RAL is 16,700 mg/kg for surface soils and no remediation is required for subsurface soils (i.e., soils deeper than 6 inches). Additionally, because the exposure scenario anticipates a non-intrusive use, no removal will be proposed beneath areas of existing pavement. The drainage ditches are considered to be part of the "grass areas" and will therefore be remediated to the 16,700 mg/kg RAL.

Additional sediment sampling is proposed in the drainage ditch that drains around the west side of the Citizens Gas property from the railroad right of way. A description of the proposed sampling is provided in the CMS Activities Summary Report.

ATTACHMENT 1

CORRECTIVE MEASURES STUDY ACTIVITIES SUMMARY REPORT

Prepared For:

REFINED METALS CORPORATION

Prepared By:

ADVANCED GEOSERVICES CORP.
West Chester, Pennsylvania

Project No. 2003-1046-02
June 22, 2004
Revised October 12, 2004

CORRECTIVE MEASURES STUDY
ACTIVITIES SUMMARY REPORT

Prepared For:

REFINED METALS CORPORATION

Prepared By:

ADVANCED GEOSERVICES CORP.
West Chester, Pennsylvania

Project No. 2003-1046-02
June 22, 2004
Revised October 12, 2004

PROFESSIONAL
PAUL GERARD STRATMAN
No. 2112
STATE OF
INDIANA
GEOLOGIST

Paul G. Stratman, P.G.
P.G. License No. 2112

TABLE OF CONTENTS

PAGE NO.

LIST OF FIGURES

FIGURE

TABLE OF CONTENTS

(Continued)

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 GENERAL

This Corrective Measures Study Activities Summary Report has been submitted by Advanced GeoServices Corp. (AGC) on behalf of Refined Metals Corporation (RMC). This report presents and discusses the methods and procedures used to implement the scope of work as proposed in the Phase II RCRA Facility Investigation (RFI) Report. Groundwater monitoring well installation and sampling activities were conducted by AGC. These activities consisted of installing three piezometers and two groundwater monitoring wells, groundwater sampling and sediment sampling at on-site and off-site locations. Laboratory sample analysis was performed by TriMatrix Laboratories Inc. (TriMatrix) of Grand Rapids, Michigan.

The RMC facility was the location of secondary lead smelting operations from 1968 through 1995. RMC was involved in the reclamation of lead from used automotive and industrial batteries and other lead bearing materials. The Site ceased smelting operations on December 31, 1995. Additional background and facility operation can be found in the Phase II RCRA Facility Investigation Report, dated November 18, 2002.

During its operational life, the facility handled materials that were classified as hazardous materials or hazardous wastes under the Resource Conservation and Recovery Act (RCRA). At this time, the Site is idle except for the wastewater treatment system which remains in operation. The wastewater treatment system remains in place to collect and treat stormwater runoff from the lined lagoon and other Site areas.

2.0 WELL INSTALLATION ACTIVITIES

2.1 INTRODUCTION

Background and facility operation information can be found in the Phase II RCRA Facility Investigation Report, dated November 18, 2002. During the Corrective Measures Study (CMS) three temporary piezometers and two groundwater monitoring wells were installed by Boart Longyear, Environmental Division, from Greensberg, Indiana. The three piezometers were installed using a truck mounted Geoprobe in the area north and east of the former manufacturing area. The piezometers were installed for the purpose of refining groundwater flow prior to selection of locations to install two new wells. Geoprobe borings were advanced into the shallow perched groundwater and the piezometer was constructed using a one (1) inch diameter PVC 0.010 screen. The piezometers were constructed on September 4, 2003 as follows:

	Depth of Boring	Depth of Piezometer	Screen Length	GW Elevation 9/05/2003
GP-1	20’	18.0’	15’	837.63
GP-2	15’	14.8’	10’	839.30
GP-3	25’	23.5’	15’	877.89

Groundwater level measurements were taken from the existing monitoring wells north of the former manufacturing area and piezometers on September 5, 2003 and the locations for two new groundwater-monitoring wells were selected.

The two groundwater monitoring wells were installed between September 8-10, 2003 and designated as MW-10 and MW-11. Groundwater monitoring well MW-10 is located east of MW-2 within the wooded area as shown on Figure 2-1. The depth of the boring for MW-10 was recorded to be 36 feet below ground surface (bgs). Groundwater monitoring well MW-11 is located approximately 156 feet east of MW-8 along the fence line of Arlington Avenue. The

depth of the boring for MW-11 was measured at 30 feet bgs. The locations of both wells installed are shown on Figure 2-1.

2.1.1 Drilling Methods

The soil borings were advanced using hollow stem auger (HSA) techniques and continuous split spoon samples were collected in accordance with ASTM D 1586. The logs for the borings and well construction completed as part of this investigation are included in Appendix A. The samples recovered from the advancement of the deep borings were logged and described using USCS soil classification.

2.1.2 Groundwater Monitoring Well Construction

The monitoring wells were constructed using a 4-inch ID, flush-threaded, Schedule 40 PVC riser with a 10-foot length of factory-slotted 0.010-inch PVC well screen. A sand pack was placed to 2 feet above the top of the monitoring well screen with No. 5 sand. A minimum 2-foot thick bentonite seal was placed on top of the sand pack.

All monitoring wells were completed with a steel protective casing with a locking cap. The protective casing extends from an approximate depth of 3 feet bgs to approximately 2 feet above ground. A neat cement seal was placed around the protective casing to a depth of 2.5 to 3 feet bgs. A 2-foot square well pad was installed so that the surface slopes away from the well.

2.1.3 Groundwater Monitoring Well Development Method

Each groundwater monitoring well installed as part of this Corrective Measures Study field activities were developed using the surge-block and pump method. Groundwater monitoring wells were first surged using a plunger-type surge block assembly. This provides the necessary turbulence in and immediately surrounding the well screen to remove fine-grained material. The wells were then purged and developed by continuous pumping using a electric submersible

pump. Well development ceased when the development water in each well was relatively sediment free, exhibited a satisfactory visual clarity and yield.

2.2 GROUNDWATER SAMPLING

2.2.1 Groundwater Well Evacuation

Following the installation of the two additional groundwater monitoring wells, groundwater samples were collected. The sampling event took place on October 26-29, 2003. Groundwater samples were obtained from groundwater monitoring wells MW-1, MW-2, MW-3, MW-4, MW-5, MW-6SR, MW-7, MW-8, MW-9, MW-10 and MW-11. A total of 11 groundwater samples were collected at the Site (excluding QA/QC samples). A low-flow sampling technique was employed to more accurately determine the potential for site-related constituents which may have entered the groundwater.

Each groundwater monitoring well was purged using a stainless steel low-flow bladder pump placed at the midpoint of the screen in each well. The wells were purged at a flow rate ranging from 100 to 300 milliliters per minute mls/min, depending on the yield of the well. A flow-through cell was used to measure the following field parameters: pH, temperature, conductivity, redox potential, and dissolved oxygen prior to contact with oxygen. These parameters were collected at 3 to 5 minute intervals during purging event. Turbidity was also measured at the same time interval. The wells were purged until the field parameters stabilize to within 10% over three readings and pH readings differ by less than 0.1 unit.

2.2.2 Groundwater Sample Collection

Once the field parameters had stabilized, samples were collected directly from the pump discharge line into laboratory-supplied bottles containing the necessary preservatives at a sampling flow rate of 100 to 300 mls/min.

Sample containers were labeled with a unique identifying number, time and date of sample collection, requested analysis, preservative, and the initials of the sample collector. Samples were packed on ice and shipped to TriMatrix Laboratories Inc. for analysis of eight RCRA metals and antimony (SW-846 6010). Samples for dissolved metals analyses were field filtered through a dedicated disposable Nalgene 0.45 μm membrane filter immediately after collection and prior to preservation. The sample was decanted into the dedicated, Nalgene disposable filtration unit and filtered under vacuum pressure created by a hand-held pump. The sample was then immediately transferred to a laboratory supplied bottleware.

3.0 SEDIMENT SAMPLING

Sediment samples were collected from four locations along the drainage ditch running parallel to Arlington Avenue and from six locations along the CSX rail line drainage ditch. The samples collected along the Arlington Avenue drainage ditch were designated R2SED-11 through R2SED-14. The samples collected along the CSX line were designated R2SB25 through R2SB-30. The location of the sediment samples are presented on Figure 3-1. The CMS Work Plan specified collection of two sediment samples from each location at depths of 0 to 6 inches and 6 to 12 inches. Along Arlington Avenue, the samples (designated R2SED-11 through R2SED-14) were collected from the 0 to 6-inch depth and the 6 to 12-inch depth as specified for sediment samples. Along the CSX railroad right-of-way, the samples (designated R2SB25 through R2SB-30) were inadvertently collected following the sample intervals utilized for soil sampling of 0 to 3 inches and 3 to 10 inches. The deviation was not identified until after the completion of sampling activities. The data has been retained and presented in this report, however the results are likely biased towards a higher concentration than the intended sample depths would have produced. This is because off-site sediment impacts from facility operations are likely attributable to stormwater runoff and/or air deposition and because metals are not expected to migrate vertically any applicable distance. For this reason, it is expected that impacts from facility operations would be greater near the surface and would relapse rapidly with depth.

The depth of collection was placed as a suffix to each sample location to delineate in which depth the result is correlated. All sediment samples were collected using decontaminated hand augers. The sediment from each interval was thoroughly homogenized in an aluminum mixing pan and was placed directly into a laboratory supplied jar. Each sediment sample was then placed on ice for shipment and was submitted to TriMatrix to be analyzed for arsenic and lead (EPA Method SW-846 6010B).

4.0 RESULTS

4.1 GROUNDWATER

4.1.1 Groundwater Screening

Arsenic and lead are the two site constituents of concern (COCs) that were detected at levels above the concentrations used for initial groundwater screening purposes. A background concentration was calculated for initial screening of arsenic in groundwater. The background concentrations for arsenic in groundwater has been calculated to be 8.5 µg/l, which is the mean concentration taken from MW-9 plus one standard deviation. The current EPA Region 9 Preliminary Remediation Goals for Tap Water do not provide a standard for lead in groundwater; therefore, we are utilizing the Indiana Department of Environmental Management (IDEM) Residential Default RISC criteria of 15 µg/l. The IDEM Residential Default RISC criteria for arsenic is 50 µg/l.

4.1.2 Groundwater Sampling Results

The analytical results for samples collected from the on-site wells for the groundwater sampling event are presented in Table 4-1. A groundwater surface map is shown as Figure 4-1. October 2003 sample results are provided in Figure 4-2.

Total arsenic was found in groundwater samples at concentrations ranging from 1.3 µg/l in MW-4 to 290 µg/l in MW-7. Arsenic concentrations were detected above the background concentration in MW-1 (24 µg/l), MW-2 (15 µg/l), MW-3 (28 µg/l), MW-5 (8.8 µg/l), MW-7 (290 µg/l), MW-8 (19 µg/l) and MW-10 (24 µg/l). Only MW-7 exceeded the IDEM Residential Default RISC Criteria for arsenic in groundwater.

Total lead was found in groundwater samples at concentrations ranging from below laboratory detection level in MW-1, MW-3, MW-4, MW-10, and MW-11 to 217 μg/l in MW-7. Lead concentrations were detected above the IDEM Residential Default Risk Criteria concentration in MW-2 (44 μg/l), MW-7 (217 μg/l) and MW-8 (55 μg/l). The only filtered sample at or above 15 μgl was MW-8 at a concentration of 15 μgl.

4.2 SEDIMENT

4.2.1 Sediment Screening

Arsenic and lead are the two site constituents of concern (COCs) that were detected at levels above their initial screening levels for soil and sediment. Samples collected from the drainage ditches are referred to as sediment in this report; however, because of the physical character of the material sampled and geomorphic setting, they are compared to the soil standards. The calculated background arsenic in soil concentrations are 10.53 mg/kg for surface soil (0-3 inch) and 7.91 mg/kg (>3 inches) for subsurface soils. Based on the Baseline Human Health Risk Assessment (Attachment 2), the target cleanup level for lead in soil at the Site is 15,916 mg/kg for surface (0-6 inches) soil.

4.2.2 Sediment Sampling Results

The validated analytical results for the sediment samples collected within the drainage ditch along Arlington Avenue and the drainage ditch along the CSX rail line are provided in Table 4-2, and a copy of the validation report is provided in Appendix B.The depth of collection was placed as a suffix to each sample location to delineate to show to which depth the result is correlated.

Concentrations of lead in the samples collected at the depth of 0-3 inches ranged from 617 mg/kg at R2SB25 to 14,800 mg/kg at R2SB29, and concentrations of arsenic ranged from 12 mg/kg at R2SB30 to 169 mg/kg at R2SB26 at this depth. The calculated background concentration for

arsenic was exceeded in all samples. The Baseline Human Health Risk Assessment (HHRA) cleanup level for lead was not exceeded in these samples.

Concentrations of lead in the samples collected at the depth of 0-6 inches ranged from 411 mg/kg at R2SED-12 to 874 mg/kg at R2SED-11, and concentrations of arsenic ranged from 11 mg/kg at R2SED-14 and R2SED-12 to 12 mg/kg at R2SED-11 and R2SED-13 at this depth. Table 4-2 presents lead and arsenic results within this depth interval. The calculated background concentration for arsenic was exceeded in all samples. The HHRA cleanup level for lead was not exceeded in these samples.

Concentrations of lead in the samples collected at the depth of 3-10 inches ranged from 403 mg/kg at R2SB28 to 15,700 mg/kg at R2SB29, and concentrations of arsenic ranged from 9 mg/kg at R2SB30 to 216 mg/kg at R2SB29 at this depth. Table 4-2 presents lead and arsenic results within this depth interval. The calculated background concentration for arsenic was exceeded in all samples. The HHRA cleanup level for lead was not exceeded in these samples.

Concentrations of lead in the samples collected at the depth of 6-12 inches ranged from 24 mg/kg at R2SED-14 to 1,470 mg/kg at R2SED-11, and concentrations of arsenic ranged from 8.3 mg/kg at R2SED-13 to 15 mg/kg at R2SED-11 at this depth. The calculated background concentration for arsenic was exceeded in all samples. The HHRA cleanup level for lead was not exceeded in these samples.

5.0 SUMMARY

The following are drawn from the findings of the Corrective Measures Study activities:

Groundwater

- Thin discontinuous zones of higher permeability glacial soils in (sand) clayey silt and silty clay characterize the shallow zone of saturation.

- Potentiometric groundwater maps for the shallow wells indicate a high point in the vicinity of MW-1. Those maps also show a trough in the groundwater surface oriented north-south through MW-8, MW-6SR and MW-4. The presence of the trough is believed to be the result of the discontinuous semi-confined zones of saturated sand or a groundwater mounded created by periodic standing water in the flat lawn area between the paved manufacturing areas and Arlington Avenue.

- Arsenic concentrations exceeded the calculated background concentration in all but four of the samples tested.

- Lead detected above the IDEM Residential Default RISC Criteria is limited to MW-2S (18 µg/l), MW-7S (217 µg/l) and MW-8S (28 µg/l) immediately north of the manufacturing area where elevated soil lead concentrations exist.

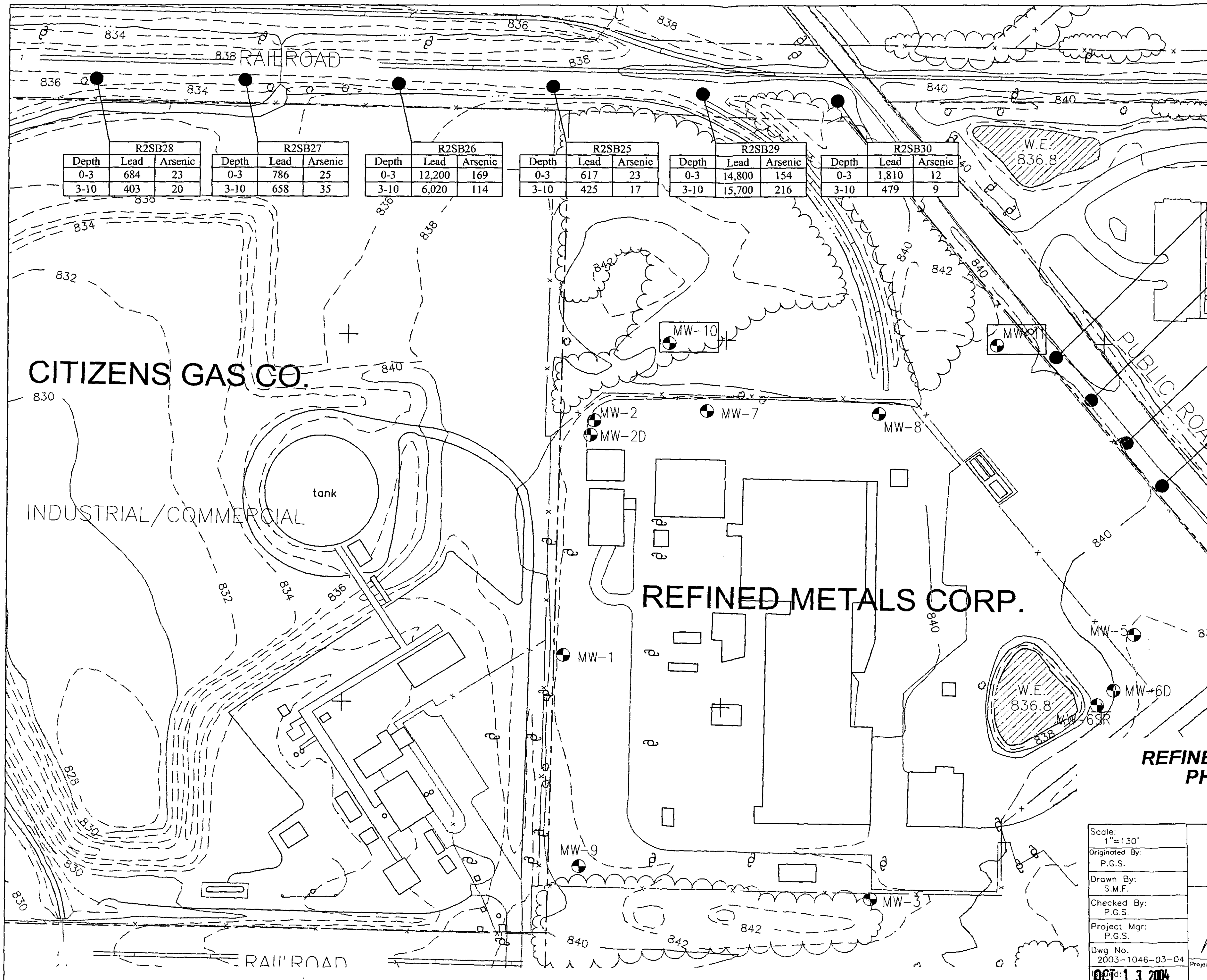
Sediment

- Elevated arsenic in sediment in the drainage ditch along the CSX line northeast of the Site indicate that off-site transport of sediment has probably occurred. To further delineate these impacts, additional sediment samples shall be collected from the drainage channel that begins at the rail road right-of-way between RS2B-26 and RS2B-27 and flows across the Citizens Gas property. Nine (9) additional locations will be sampled. Similar to sediment samples previously collected along the CSX line, the samples will be uniformly distributed at approximately 200 feet on-center. Sampling will be performed following the criteria established for sediment samples in the Phase 2 RFI Work Plan.

- The most downstream sediment samples from the grass lined swale along Arlington Avenue are below 100 mg/kg total lead. Based on this result no additional sampling is proposed along Arlington Avenue.

- All sediment sample results for lead are shown to be below the RAL calculated in the Baseline Human Health Risk Assessment.

FIGURES



R2SB28

Depth	Lead	Arsenic
0-3	684	23
3-10	403	20

R2SB27

Depth	Lead	Arsenic
0-3	786	25
3-10	658	35

R2SB26

Depth	Lead	Arsenic
0-3	12,200	169
3-10	6,020	114

R2SB25

Depth	Lead	Arsenic
0-3	617	23
3-10	425	17

R2SB29

Depth	Lead	Arsenic
0-3	14,800	154
3-10	15,700	216

R2SB30

Depth	Lead	Arsenic
0-3	1,810	12
3-10	479	9

R2SED-14

Depth	Lead	Arsenic
0-6	681	11
6-12	24	9.5

R2SED-13

Depth	Lead	Arsenic
0-6	771	12
6-12	28	8.3

R2SED-12

Depth	Lead	Arsenic
0-6	471	11
6-12	32	9.3

R2SED-11

Depth	Lead	Arsenic
0-6	874	12
6-12	1,470	15

REFINED METALS CORPORATION
PHASE I CMS ACTIVITIES
SUMMARY REPORT
BEECH GROVE, INDIANA

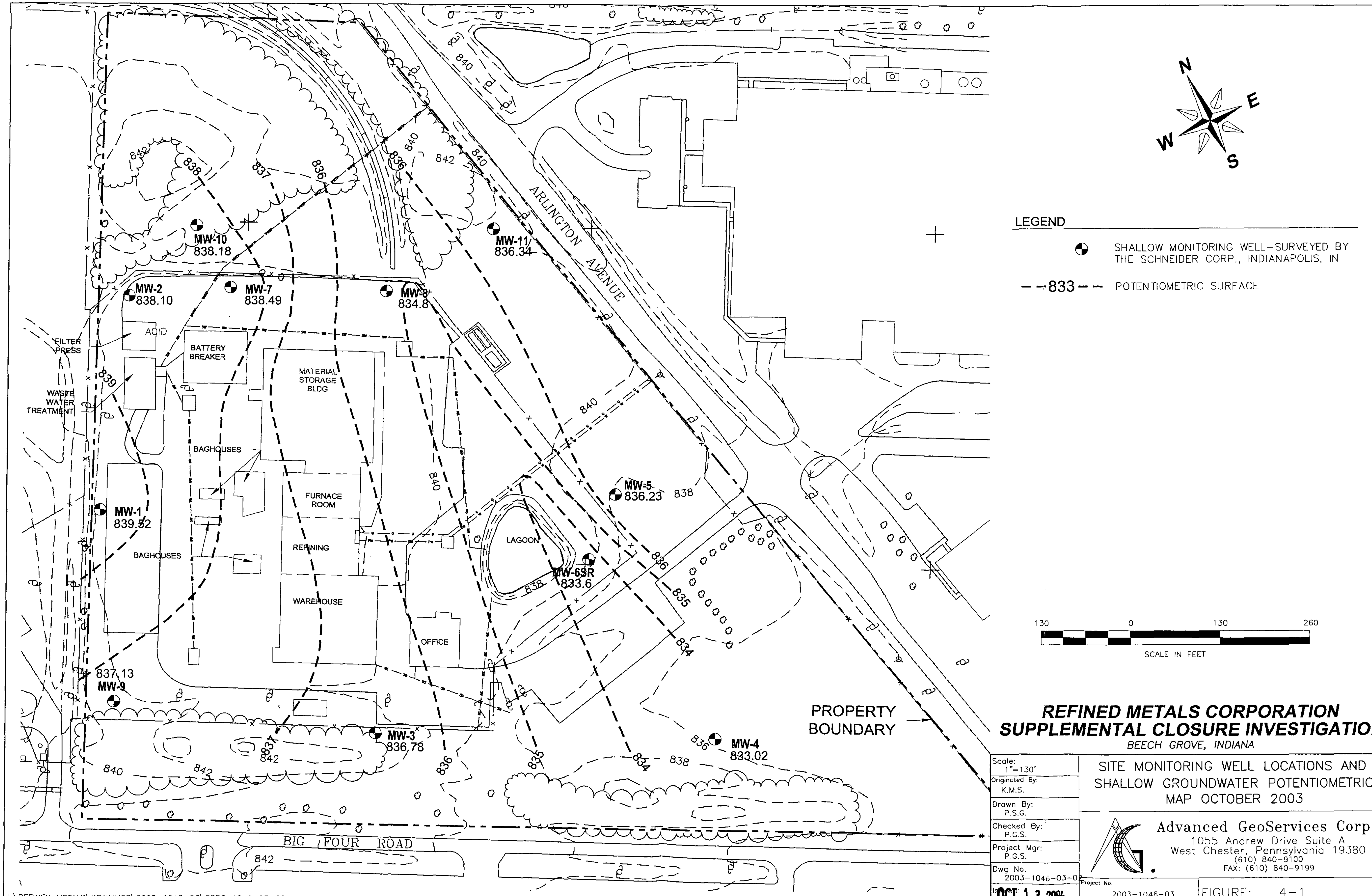
SEDIMENT SAMPLE RESULTS

Scale: 1"=130'
Originated By: P.G.S.
Drawn By: S.M.F.
Checked By: P.G.S.
Project Mgr: P.G.S.
Dwg No. 2003-1046-03-04
Date: OCT 1 3 2004
Project No. 2003-1046-03

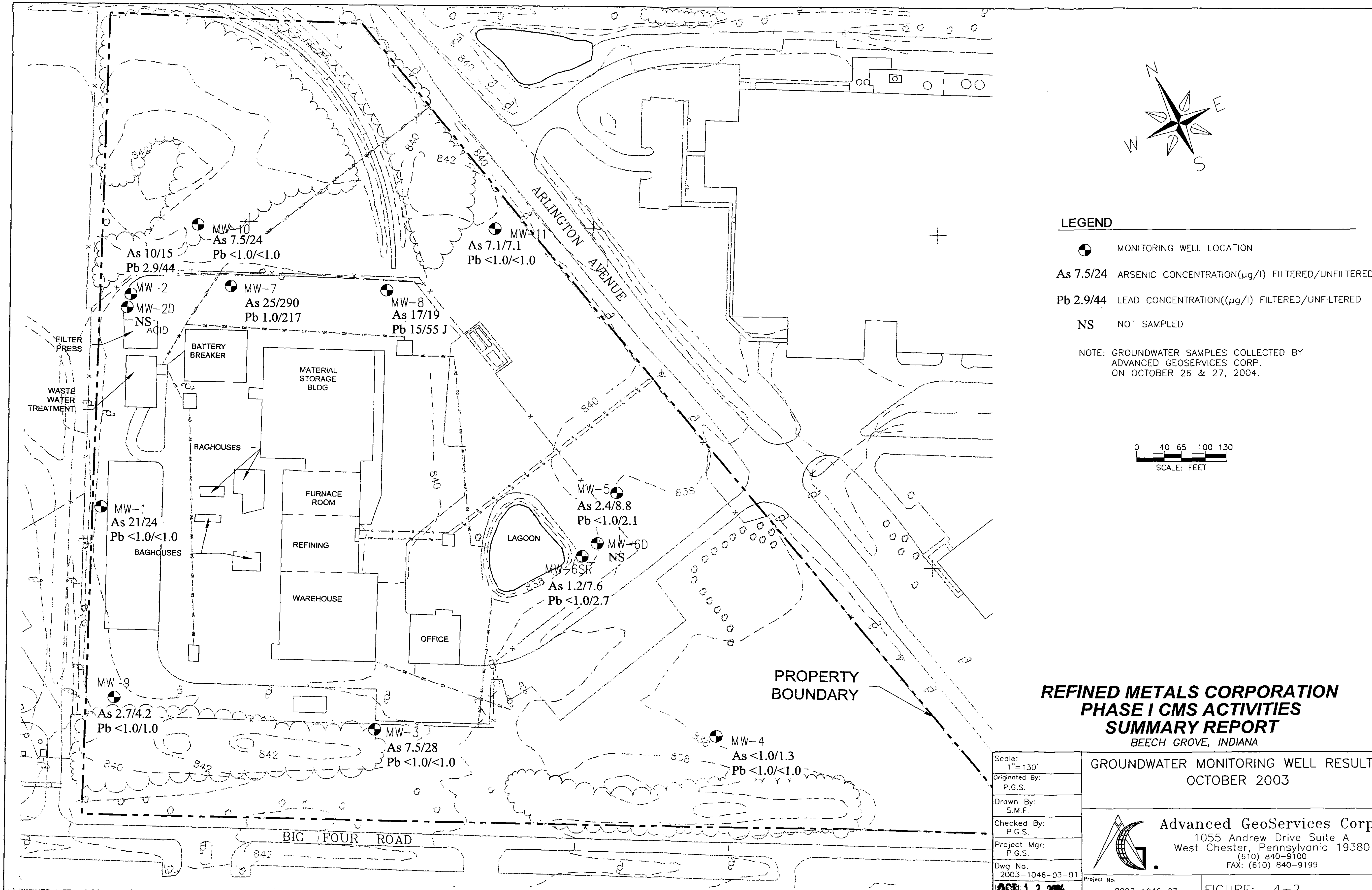
Advanced GeoServices Corp.
1055 Andrew Drive Suite A
West Chester, Pennsylvania 19380
(610) 840-9100
FAX: (610) 840-9199

FIGURE: 3-1

J:\REFINED METALS\DRAWINGS\2003-1046-03\2003-1046-03-04



LEGEND
SHALLOW MONITORING WELL-SURVEYED BY THE SCHNEIDER CORP., INDIANAPOLIS, IN
--833-- POTENTIOMETRIC SURFACE
N
E
S
W
ARLINGTON AVENUE
BIG FOUR ROAD
MW-10 838.18
MW-11 836.34
MW-2 838.10
MW-7 838.49
MW-8 834.8
MW-1 839.52
MW-5 836.23
MW-6SR 833.6
MW-9 837.13
MW-3 836.78
MW-4 833.02
ACID
FILTER PRESS
WASTE WATER TREATMENT
BATTERY BREAKER
MATERIAL STORAGE BLDG
BAGHOUSES
FURNACE ROOM
REFINING
WAREHOUSE
OFFICE
LAGOON
PROPERTY BOUNDARY
130 0 130 260
SCALE IN FEET
REFINED METALS CORPORATION
SUPPLEMENTAL CLOSURE INVESTIGATION
BEECH GROVE, INDIANA
SITE MONITORING WELL LOCATIONS AND SHALLOW GROUNDWATER POTENTIOMETRIC MAP OCTOBER 2003
Scale: 1"=130'
Originated By: K.M.S.
Drawn By: P.S.G.
Checked By: P.G.S.
Project Mgr: P.G.S.
Dwg No. 2003-1046-03-02
OCT 1 3 2004
Project No. 2003-1046-03
Advanced GeoServices Corp.
1055 Andrew Drive Suite A
West Chester, Pennsylvania 19380
(610) 840-9100
FAX: (610) 840-9199
FIGURE: 4-1
J:\REFINED METALS\DRAWINGS\2003-1046-03\2003-1046-03-02



REFINED METALS CORPORATION
PHASE I CMS ACTIVITIES
SUMMARY REPORT

BEECH GROVE, INDIANA

Scale: 1"=130'	GROUNDWATER MONITORING WELL RESULTS OCTOBER 2003
Originated By: P.G.S.	
Drawn By: S.M.F.	
Checked By: P.G.S.	Advanced GeoServices Corp. 1055 Andrew Drive Suite A West Chester, Pennsylvania 19380 (610) 840-9100 FAX: (610) 840-9199
Project Mgr: P.G.S.	
Dwg No. 2003-1046-03-01	Project No. 2003-1046-03
OCT 1 3 2004	FIGURE: 4-2

J:\REFINED METALS\DRAWINGS\2003-1046-03\2003-1046-03-01

APPENDIX A

Geoprobe and Monitoring Well Logs

BOART LONGYEAR | **FIELD BORING LOG** | **Sheet** 1 **Of** 1

FOR	Adv. Geoservices — Refined Metals	**Job No.**	3417-1807-36
LOCATION	Beech Grove IN — **Elev.**	**Boring No.**	GP 3

GROUND WATER					
While drilling		Time after drilling		Start	9/9/03
Before casing removal		Depth to water		Unit	837
After casing removal		Depth to cave-in		Chief	Alan

Casing/Probe Weight / Drop

Sample No.	Moisture	Blows on Sampler 0/6	Blows on Sampler 6/12	Sample Rec.	Total Blows	Depth	VISUAL FIELD CLASSIFICATION AND REMARKS	Depth	Unconfined Strength	Boulders	Blows on Casing Size	Blows on Probe Size	Drilling Method
							Topsoil						6 1/4 H.S.A
							Firm gray-brown mottled silty clay (dry)						
						5		5					
							8.0'						
							Firm brown silty clay with gravel (dry)						
						10		10					
							13.5'						
						15	Stiff gray ~~silty~~ CLAY (moist)	15					
							16.0'						
							Gray sandy clay (wet) 17.0'						
							Stiff gray brown silty clay (dry)						
						20	Same 20.0'	20					
							No Recovery, sand trapped in sample sleeve, some standing water in hole at 18'						
						25	25.0	25					
							EOB 25'						
						30		30					
						35		35					
						40		40					
						45		45					
						50		50					

BOARTLONGYEAR | **FIELD BORING LOG** | Sheet 1 Of 1

FOR Adv. Geoservices Refined Metals | Job No. 3417-1807-36

LOCATION Beech Grove IN Elev. | Boring No. GP 2

GROUND WATER				
While drilling	5.0'	Time after drilling		Start 9/9/03
Before casing removal	NA	Depth to water		Unit 837
After casing removal	NA	Depth to cave-in		Chief Alan

Casing/Probe NA
Weight NA
Drop NA

Sample No.	Moisture	Blows on Sampler 0/6	Blows on Sampler 6/12	Sample Rec.	Total Blows	Depth	VISUAL FIELD CLASSIFICATION AND REMARKS	Depth	Unconfined Strength	Boulders	Blows on Casing Size	Blows on Probe Size	Drilling Method
							Soft dark gray Topsoil 1.0'						6 1/4
							Hard brown gray mottled silty clay (dry) ~~Clay~~						H.S.A
							becoming ~~wet~~ moist at 3'						
						5	5.0'	5					
							Wet Sand 6.0						
							Stiff tan/brown mottled clay with gravel						
							~~Same~~						
						10		10					
							stiff brown gray mottled clay						
							~~Sand~~						
							Stiff gray clay with gravel and small cobbles						
						15		15					
							EOB 15'						
						20		20					
						25		25					
						30		30					
						35		35					
						40		40					
						45		45					
						50		50					

BOART LONGYEAR

FIELD BORING LOG

Sheet 1 Of 1

FOR Adv. Geoservices Refined Metals

Job No. 3417-1807-36

LOCATION Beech Grove IN Elev.

Boring No. GP 1

GROUND WATER					
While drilling	13.0'	Time after drilling			Start 9/9/03
Before casing removal	NA	Depth to water			Unit 837
After casing removal	NA	Depth to cave-in	15'		Chief Alan

Casing/Probe NA
Weight NA
Drop NA

Depth	VISUAL FIELD CLASSIFICATION AND REMARKS	Depth to change	Drilling Method
0	Topsoil		~~5 1/4~~
	Soft tan/brown silty ~~Clay~~ Clay (moist)		~~HSA~~ Geop
5		5.0'	
	Soft tan/brown to gray silty Clay (with rounded gravel below 6') dry ~~Same~~		
10		10.5'	
	Gravel and Clay seam (moist) ~~Same~~	10.7'	
	Stiff brown silty Clay with gravel (moist) (wet below 13.0')	▽ 13.0'	
15		15.2'	
	Brown gray silty ~~Sand~~ Sand (saturated)		
		19.0'	
20	Hard gray Clay with gravel (dry)	20.0'	
	EOB 20'		

Column headings (blank): Sample No., Moisture, Blows on Sampler 0/6, 6/12, Sample Rec., Total Blows, Unconfined Strength, Boulders, Blows on Casing Size, Probe Size. Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50.

FIELD BORING LOG

BOART LONGYEAR

Sheet 1 Of 1

FOR Adv. Geoservices Refined Metals

LOCATION Beech Grove IN Elev.

Job No. 3417-1807-36

Boring No. MW 10

GROUND WATER While drilling ___ Time after drilling ___
Before casing removal ___ Depth to water ___
After casing removal ___ Depth to cave-in ___

Start 9/9/03
Unit 822
Chief Dan

Casing/Probe Weight ___ Drop ___

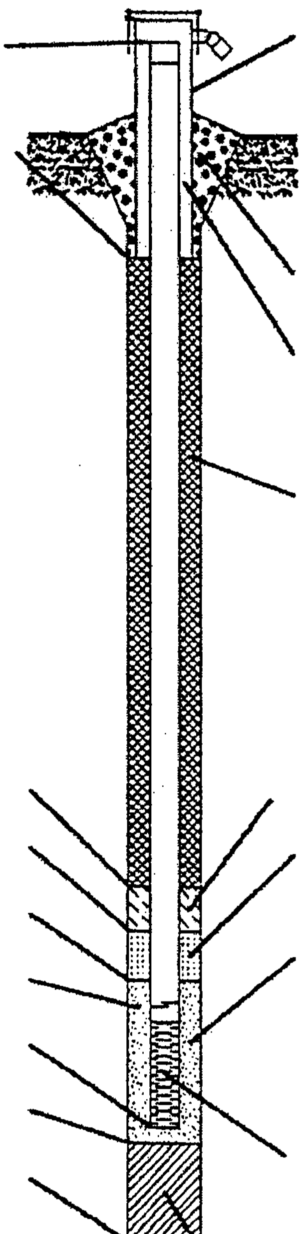
Sample No.	Moisture	Blows on Sampler 0/6	Blows on Sampler 6/12	Sample Rec.	Total Blows	Depth	VISUAL FIELD CLASSIFICATION AND REMARKS	Unconfined Strength	Boulders	Blows on Casing Size	Blows on Probe Size	Drilling Method
						0	Topsoil					6 1/4
							Br. Silty Clay					H.S.A
						5						
1	D	5	8									
		12	12	2.0	20							
						10	M-C Br. Sand w/ Gravel					
2	W	7	34				Gray Silty Clay					
		45	25	1.5	79							
						15						
3	W	5	17				Gray Silty Clay					
		43	46	1.5	60							
4	W	10	20									
		25	26	1.2	45							
5	W	10	23			20						
		27	30	1.5	60							
6	W	8	10									
		14	16	1.2	24							
							EOB 23'					
						25	Set Well @ 19'					
						30						
						35						
						40						
						45						
						50						

BOART LONGYEAR
Well Construction Report

Job Name: Refined Metals
Job Number: 3417-1807-36
Location: Beech Grove, IN

Well Name: MW-10
Driller: D. Harrison
Helper: ____
Date Installed: 09/09/03

Type of Well:
X Water Table Observation
__ Piezometer
__ Other ____



A. Height of Well Casing above ground: 3.0 ft.

B. Diameter of Well Casing: 4.0 in.

C. Surface Seal Bottom: 1.0 ft.

D. Well Casing: Flush Threaded PVC
X Schedule 40
__ Schedule 80
__ Other ____

E. Bentonite Seal Top: 2.0 ft.

F. Fine Sand Top: ____ ft.

G. Filter Pack Top: 7.0 ft.

H. Screen Joint Top: 9.0 ft.

I. Well Bottom: 19.0 ft.

J. Filter Pack Bottom: 19.0 ft.

K. Borehole Bottom: 23.0 ft.

1. Locking Cap? X Yes __ No

2. Protective Cover:
   a. Inside diam. 6.0 in.
   b. Length 5.0 ft.
   c. Material
      X Steel
      __ Other ____
   d. Bumper Post No qty
      __ 3" __ 4"

3. Surface Seal:
   __ Bentonite
   X Concrete
   __ Other ____

4. Material between Casing and Protop:
   __ Bentonite
   __ Other ____

5. Annular Space Seal:
   __ Granular Bentonite
   __ Bentonite Slurry
   __ Cement-Bentonite Grout
   __ Other ____
   How Installed:
   __ Gravity
   __ Tremie Pumped

6. Bentonite Seal:
   X Granules
   __ Pellets

7. Type of Fine Sand:
   ____

8. Type of Filter Pack:
   #5

9. Screen Material: PVC
   Type: X Factory Cut
   __ Continuous Slot
   Slot Size: 0.010 in.
   Length: 10.0 ft.

10. Backfill Material: (Below filter pack)
   __ None
   X Other Sand

Boart Longyear
5815 Churchman Ave., Suite 2
Indianapolis, IN 46203
Phone (317) 784-1838
Fax (317) 784-2035

BOART LONGYEAR

FIELD BORING LOG

Sheet 1 Of 1

FOR Adv. Geoservices Refined Metals

LOCATION Beech Grove IN Elev.

Job No. 3417-1807-36

Boring No. MW 11

GROUND WATER			
While drilling		Time after drilling	
Before casing removal		Depth to water	
After casing removal		Depth to cave-in	

Start 9/9/03
Unit 822
Chief Dan

Depth	Sample No.	Moisture	Blows on Sampler 0/6	Blows on Sampler 6/12	Sample Rec.	Total Blows	VISUAL FIELD CLASSIFICATION AND REMARKS	Unconfined Strength	Boulders	Blows on Casing Size	Blows on Probe Size	Drilling Method
							Topsoil					6 1/4
							Br. Silty Clay					H.S.A
5												
	1		8	19								
			42	36	1.8	61						
10												
	2		10	12								
			18	15	1.8	30						
15												
	3		10	24			M-C Sand					
			10	17	1.2	34	Br. Silty Clay					
	4		12	17								
			34	75	1.2	51						
20	5		15	59			M-F Br. Silty Sand					
			69	58	1.5	128						
	6		15	19			Gray M-F Sand					
			20	23	1.8	39						
							EOB 23'					
25							Set Well @ 23'					
30												
35												
40												
45												
50												

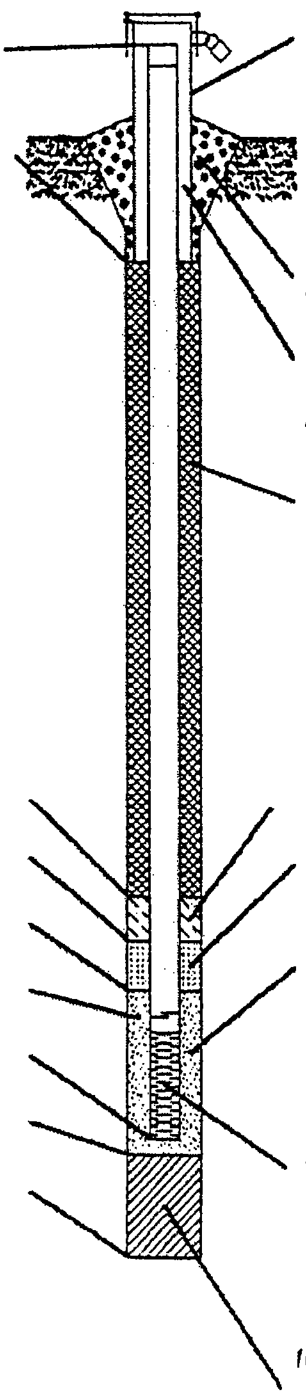
Casing/Probe Weight Drop

BOART LONGYEAR
Well Construction Report

Job Name Refined Metals
Job Number 3417-1807-36
Location Beech Grove, IN

Well Name MW-11
Driller D. Harrison
Helper ______
Date Installed 09/09/03

Type of Well:
X Water Table Observation
___ Piezometer
___ Other ______



A. Height of Well Casing above ground 3.0 ft.

B. Diameter of Well Casing 4.0 in.

C. Surface Seal Bottom 1.0 ft.

D. Well Casing: Flush Threaded PVC
X Schedule 40
___ Schedule 80
___ Other ______

E. Bentonite Seal Top 2.0 ft.

F. Fine Sand Top ___ ft.

G. Filter Pack Top 10.5 ft.

H. Screen Joint Top 13.0 ft.

I. Well Bottom 23.0 ft.

J. Filter Pack Bottom 23.0 ft.

K. Borehole Bottom 23.0 ft.

1. Locking Cap? X Yes ___ No
2. Protective Cover:
   a. Inside diam. 6.0 in.
   b. Length 5.0 ft.
   c. Material
      X Steel
      ___ Other ______
   d. Bumper Post No qty
      ___ 3" ___ 4"
3. Surface Seal:
   ___ Bentonite
   X Concrete
   ___ Other ______
4. Material between Casing and Protop:
   ___ Bentonite
   ___ Other ______
5. Annular Space Seal:
   ___ Granular Bentonite
   ___ Bentonite Slurry
   ___ Cement-Bentonite Grout
   ___ Other ______
   How Installed:
   ___ Gravity
   ___ Tremie Pumped
6. Bentonite Seal:
   ___ Granules
   ___ Pellets
7. Type of Fine Sand: ______
8. Type of Filter Pack: #5
9. Screen Material: PVC
   Type: X Factory Cut
   ___ Continuous Slot
   Slot Size: 0.010 in.
   Length: 10.0 ft.
10. Backfill Material: (Below filter pack)
    ___ None
    ___ Other ______

Boart Longyear
5815 Churchman Ave., Suite 2
Indianapolis, IN 46203
Phone (317) 784-1838
Fax (317) 784-2035

APPENDIX B

Sediment Sampling Data – October 2003 Groundwater Data

TABLE 4-1
Groundwater Sampling,
10/26 - 10/28/2003

Sample Location		MW-4			MW-6			MW-3			MW-3D			MW-5			EB-1-102603			MW-11			MW-7S		
Lab ID		348075			348076			348077			348078			348079			348080			348081			348082		
Sample Date		10/26/2003			10/26/2003			10/26/2003			10/26/2003			10/26/2003			10/26/2003			10/27/2003			10/27/2003		
Matrix		Groundwater			Groundwater			Groundwater			Groundwater			Groundwater			Aqueous			Groundwater			Groundwater		
Remarks											FD of MW-3						Equipment Blank								
Parameter	**Units**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**
Total Metals																									
Antimony	ug/L		U	10		U	10		U	10		U	10		U	10		U	10		U	10		U	10
Arsenic	ug/L	1.3		1	7.6		1	28		1	27		1	8.8		1		U	1	7.1		1	290		1
Barium	ug/L	276		10	228		10	84		10	80		10	159		10		U	10	167		10	17		10
Cadmium	ug/L		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Chromium	ug/L		U	1	4.5		1		U	1		U	1	1.1		1		U	1	1.1		1	1.9		1
Lead	ug/L		U	1	2.7		1		U	1		U	1	2.1		1		U	1		U	1	217		1
Mercury	ug/L		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Selenium	ug/L		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2
Silver	ug/L		U	0.2		U	0.2		U	0.2	0.2		0.2		U	0.2		U	0.2		U	0.2		U	0.2
Dissolved Metals																									
Antimony	ug/L		U	10		U	10		U	10		U	10		U	10		U	10		U	10		U	10
Arsenic	ug/L		U	1	1.2		1	7.5		1	7.7		1	2.4		1		U	1	7.1		1	25		1
Barium	ug/L	213		10	117		10	73		10	76		10	154		10		U	10	167		10	15		10
Cadmium	ug/L		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Chromium	ug/L	2.1		1	2.1		1	4.9		1	4.6		1	2.2		1		U	1		U	1	7.4		1
Lead	ug/L		U	1		U	1		U	1		U	1		U	1		U	1		U	1	1		1
Selenium	ug/L		U	2		U	2	2		2		U	2		U	2		U	2		U	2		U	2

TABLE 4-1
Groundwater Sampling,
10/26 - 10/28/2003

Sample Location		MW-9			MW-1			MW-2			FB-1-102703			MW-10			MW-8S			MW-8SD			EB-2-102803		
Lab ID		348083			348084			348085			348086			348087			348088			348089			348090		
Sample Date		10/27/2003			10/27/2003			10/27/2003			10/27/2003			10/28/2003			10/28/2003			10/28/2003			10/28/2003		
Matrix		Groundwater			Groundwater			Groundwater			Aqueous			Groundwater			Groundwater			Groundwater			Aqueous		
Remarks											Field Blank									FD of MW-8S			Equipment Blank		
Parameter	**Units**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**
Total Metals																									
Antimony	ug/L		U	10		U	10		U	10		U	10		U	10		U	10		U	10		U	10
Arsenic	ug/L	4.2		1	24		1	15		1		U	1	24		1	19		1	18		1		U	1
Barium	ug/L	43		10	69		10	44		10		U	10	71		10	89		10	83		10		U	10
Cadmium	ug/L		U	0.2		U	0.2	0.2		0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Chromium	ug/L		U	1	1.3		1	2.1		1		U	1	1.6	U	1	1.1	U	1	1.5	U	1	1.2		1
Lead	ug/L	1		1		U	1	44		1		U	1		U	1	55	J	1	35	J	1		U	1
Mercury	ug/L		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Selenium	ug/L		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2
Silver	ug/L		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Dissolved Metals																									
Antimony	ug/L		U	10		U	10		U	10		U	10		U	10		U	10		U	10		U	10
Arsenic	ug/L	2.7		1	21		1	10		1		U	1	7.5		1	17		1	16		1		U	1
Barium	ug/L	41		10	69		10	22		10		U	10	16		10	79		10	76		10		U	10
Cadmium	ug/L		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Chromium	ug/L	1.9		1	6.5		1	3.1		1		U	1	5.2		1	2.9		1	2.8		1		U	1
Lead	ug/L		U	1		U	1	2.9		1		U	1		U	1	15		1	12		1		U	1
Selenium	ug/L		U	2		U	2		U	2		U	2	2.3		2		U	2		U	2		U	2

TABLE 4-2
Sediment Sampling,
10/28 - 10/29/2003

Sample Location	Lab ID	Sample Date	Matrix	Remarks	Parameter	Units	Result	Q	RL
Arsenic									
R2SED-11-0-6	348091	10/28/2003	Sediment		Arsenic	mg/kg	12		1
R2SED-11-6-12	348092	10/28/2003	Sediment		Arsenic	mg/kg	15		1
R2SED-12-0-6	348093	10/28/2003	Sediment		Arsenic	mg/kg	11		1
R2SED-12D-0-6	348094	10/28/2003	Sediment	FD of R2SED-12-0-6	Arsenic	mg/kg	12		1
R2SED-12-6-12	348095	10/28/2003	Sediment		Arsenic	mg/kg	9.3		1
R2SED-13-0-6	348096	10/28/2003	Sediment		Arsenic	mg/kg	12		1
R2SED-13-6-12	348097	10/28/2003	Sediment		Arsenic	mg/kg	8.3		1
R2SED-14-0-6	348098	10/28/2003	Sediment		Arsenic	mg/kg	11		1
R2SED-14-6-12	348099	10/28/2003	Sediment		Arsenic	mg/kg	9.5		1
R2SB30-0-3	348101	10/29/2003	Sediment		Arsenic	mg/kg	12		1
R2SB30-3-10	348102	10/29/2003	Sediment		Arsenic	mg/kg	9		1
R2SB29-0-3	348103	10/29/2003	Sediment		Arsenic	mg/kg	154		25
R2SB29-3-10	348104	10/29/2003	Sediment		Arsenic	mg/kg	216		25
R2SB25-0-3	348105	10/29/2003	Sediment		Arsenic	mg/kg	23		1
R2SB25-3-10	348106	10/29/2003	Sediment		Arsenic	mg/kg	17		1
R2SB26-0-3	348107	10/29/2003	Sediment		Arsenic	mg/kg	169		25
R2SB26-3-10	348108	10/29/2003	Sediment		Arsenic	mg/kg	114		25
R2SB27-0-3	348109	10/29/2003	Sediment		Arsenic	mg/kg	25		1
R2SB27-3-10	348110	10/29/2003	Sediment		Arsenic	mg/kg	35		1
R2SB28-0-3	348111	10/29/2003	Sediment		Arsenic	mg/kg	23		1
R2SB28-3-10	348112	10/29/2003	Sediment		Arsenic	mg/kg	20		1
R2SB28D-3-10	348113	10/29/2003	Sediment	FD of R2SB28-3-10	Arsenic	mg/kg	22		1
EB-4-102903	348114	10/29/2003	Aqueous	Equipment Blank	Arsenic	ug/L		U	1
Lead									
R2SED-11-0-6	348091	10/28/2003	Sediment		Lead	mg/kg	874		120
R2SED-11-6-12	348092	10/28/2003	Sediment		Lead	mg/kg	1470		300
R2SED-12-0-6	348093	10/28/2003	Sediment		Lead	mg/kg	411		60
R2SED-12D-0-6	348094	10/28/2003	Sediment	FD of R2SED-12-0-6	Lead	mg/kg	462		60
R2SED-12-6-12	348095	10/28/2003	Sediment		Lead	mg/kg	32		0.6
R2SED-13-0-6	348096	10/28/2003	Sediment		Lead	mg/kg	771		120
R2SED-13-6-12	348097	10/28/2003	Sediment		Lead	mg/kg	28		0.6
R2SED-14-0-6	348098	10/28/2003	Sediment		Lead	mg/kg	681		60
R2SED-14-6-12	348099	10/28/2003	Sediment		Lead	mg/kg	24		0.6
R2SB30-0-3	348101	10/29/2003	Sediment		Lead	mg/kg	1810		300
R2SB30-3-10	348102	10/29/2003	Sediment		Lead	mg/kg	479		60
R2SB29-0-3	348103	10/29/2003	Sediment		Lead	mg/kg	14800		3000
R2SB29-3-10	348104	10/29/2003	Sediment		Lead	mg/kg	15700		3000
R2SB25-0-3	348105	10/29/2003	Sediment		Lead	mg/kg	617		60
R2SB25-3-10	348106	10/29/2003	Sediment		Lead	mg/kg	425		60
R2SB26-0-3	348107	10/29/2003	Sediment		Lead	mg/kg	12200		1200
R2SB26-3-10	348108	10/29/2003	Sediment		Lead	mg/kg	6020		600
R2SB27-0-3	348109	10/29/2003	Sediment		Lead	mg/kg	786		120
R2SB27-3-10	348110	10/29/2003	Sediment		Lead	mg/kg	658		120
R2SB28-0-3	348111	10/29/2003	Sediment		Lead	mg/kg	684		120
R2SB28-3-10	348112	10/29/2003	Sediment		Lead	mg/kg	403		60
R2SB28D-3-10	348113	10/29/2003	Sediment	FD of R2SB28-3-10	Lead	mg/kg	490		60
EB-4-102903	348114	10/29/2003	Aqueous	Equipment Blank	Lead	ug/L		U	1

Well ID: MW-1 Job No: 98-478-04

Date Sampled: 10/27/2003

Sampled by: BAC

Well Diameter: 2"

DTW: 7.47

DTB: 31.56

Estimated Pump Setting: 26'

Estimated Flow Rate: 140 ml/min

Sample Collection Time: 1412

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1257	6.74	5.40	1.325	12.95	134	195.0
1300	6.79	2.62	1.51	12.66	107	340
1303	6.79	1.93	1.55	12.84	81	385
1307	6.79	1.34	1.55	13.57	58	476
1310	6.78	1.20	1.55	13.70	52	403
1314	6.79	0.87	1.54	13.73	40	270
1318	6.79	0.74	1.55	13.76	32	152.3
1321	6.79	0.67	1.54	13.55	27	98.9
1324	6.79	0.66	1.55	13.58	25	79.0
1327	6.79	0.62	1.55	13.54	21	64.8
1330	6.79	0.59	1.55	13.63	18	51.6
1333	6.79	0.57	1.55	13.67	15	47.3
1336	6.78	0.56	1.55	13.76	13	39.0
1339	6.78	0.53	1.55	13.75	11	33.6
1342	6.79	0.52	1.55	14.00	10	28.4
1345	6.79	0.52	1.55	14.06	8	20.3
1348	6.78	0.49	1.56	14.48	-3	17.5
1400	6.78	0.48	1.56	14.38	-3	15.4
1403	6.79	0.48	1.55	13.84	-5	15.2
1406	6.78	0.47	1.56	13.92	-5	14.8
1409	6.78	0.46	1.56	14.30	-6	14.2
1416	6.81	1.58	1.56	13.98	74	28.5

Comment: 3.0 gal removed

Well ID: MW-2 Job No: 98-478-04

Date Sampled: 10/27/2003

Sampled by: BAC

Well Diameter: 2"

DTW: 8.8

DTB: 31.36

Estimated Pump Setting: 26'

Estimated Flow Rate: 180 ml/min

Sample Collection Time: 1540

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1438	6.72	3.08	1.90	14.58	60	83.9
1441	6.72	1.75	1.91	14.14	47	88.1
1444	6.71	1.50	1.90	13.70	44	93.9
1448	6.70	1.11	1.89	14.61	35	58.7
1451	6.70	1.05	1.90	14.78	34	53.3
1454	6.70	0.95	1.91	15.19	28	44.7
1458	6.71	0.84	1.92	15.06	21	30.3
1502	6.71	0.75	1.92	14.46	15	21.6
1506	6.71	0.70	1.93	14.44	12	17.8
1509	6.71	0.68	1.93	14.33	10	15.1
1512	6.72	0.66	1.93	14.38	9	13.6
1515	6.72	0.65	1.93	14.43	8	12.2
1518	6.71	0.64	1.93	14.48	7	11.1
1521	6.71	0.62	1.93	14.28	5	9.8
1524	6.71	0.61	1.93	14.29	4	9.6
1527	6.72	0.59	1.93	13.91	2	8.4
1530	6.72	0.58	1.94	13.94	2	8.1
1533	6.71	0.58	1.93	13.97	1	8.0
1546	6.71	1.03	1.91	14.70	62	15.3

Comment: 3.0 gal removed

Well ID:	MW-3	Job No:	98-478-04
Date Sampled:	10/26/2003		
Sampled by:	BAC		
Well Diameter:	2"		
DTW:	11.28		
DTB:	22.36		
Estimated Pump Setting:	17'		
Estimated Flow Rate:	210 ml/min		
Sample Collection Time:	1415		
Laboratory:	Beech Grove, IN		

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1312	6.97	2.84	1.367	13.40	101	962
1315	6.95	1.62	1.389	13.82	88	957
1318	6.94	1.11	1.389	13.96	76	1058
1321	6.93	1.17	1.389	13.90	74	1108
1325	6.95	0.87	1.391	13.95	67	838
1330	6.94	0.75	1.392	13.77	56	536
1334	6.94	0.77	1.392	13.57	52	366
1337	6.95	0.74	1.392	13.46	51	362
1340	6.94	0.70	1.391	13.27	46	277
1343	6.95	0.70	1.391	13.24	46	291
1346	6.95	0.65	1.390	13.19	42	261
1349	6.96	0.64	1.390	13.16	40	179.1
1352	6.96	0.64	1.389	13.33	38	171.3
1355	6.96	0.65	1.387	13.29	36	173.8
1358	6.95	0.66	1.386	13.87	36	137.8
1401	6.96	0.65	1.387	13.87	34	122.9
1404	6.95	0.59	1.387	13.38	31	92.7
1407	6.95	0.57	1.388	13.36	28	82.1
1410	6.96	0.56	1.388	13.35	26	90.3
1413	6.96	0.54	1.389	13.39	25	84.1

Comment: Removed 3.0 gal

Well ID:	MW-4	Job No:	98-478-04
Date Sampled:	10/26/2003		
Sampled by:	BAC		
Well Diameter:	2"		
DTW:	6		
DTB:	23.97		
Estimated Pump Setting:	19'		
Estimated Flow Rate:	200ml/min		
Sample Collection Time:	1130		

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1024	7.02	3.96	0.806	14.11	365	1149
1028	7.03	1.67	0.814	14.71	283	668
1032	7.03	1.26	0.816	14.40	189	473
1036	7.02	1.14	0.814	14.02	125	447
1040	7.02	1.09	0.814	14.13	107	380
1044	7.01	1.01	0.816	14.36	89	310
1048	7.00	0.94	0.817	14.54	78	233
1052	7.00	0.89	0.819	14.36	73	128.9
1056	7.00	0.85	0.820	14.45	69	127.6
1100	7.00	0.81	0.821	14.35	65	185.3
1104	7.00	0.78	0.821	14.73	61	178.6
1108	7.00	0.75	0.822	14.61	60	261.0
1112	6.99	0.73	0.824	14.62	55	120.6
1116	6.99	0.68	0.825	14.97	52	91.6
1120	7.00	0.66	0.825	14.7	48	61.7
1123	6.99	0.65	0.825	14.53	47	52.9
1126	6.99	0.62	0.826	14.82	45	55.8
1129	6.98	0.61	0.827	15.07	44	54.4

Commen Removed 3.0 gal

Well ID:	MW-5	Job No:	98-478-04
Date Sampled:	10/26/2003		
Sampled by:	BAC		
Well Diameter:	2"		
DTW:	4.61		
DTB:	26.25		
Estimated Pump Setting:	21'		
Estimated Flow Rate:	170 ml/min		
Sample Collection Time:	1612		
Laboratory:	Beech Grove, IN		

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1445	7.16	4.15	0.759	13.29	178	413
1448	7.10	2.99	0.768	13.55	159	531
1451	7.09	2.17	0.777	13.54	150	603
1454	7.08	1.47	0.782	13.53	146	568
1457	7.09	1.39	0.781	13.52	145	406
1501	7.09	1.25	0.781	13.68	146	216
1505	7.09	1.20	0.783	13.75	145	142.1
1509	7.09	0.96	0.791	13.64	140	640
1513	7.08	0.93	0.790	13.60	140	529
1516	7.07	0.89	0.791	13.44	139	244
1519	7.07	0.87	0.791	13.35	138	151.5
1522	7.08	0.81	0.791	13.21	134	89.7
1525	7.07	0.77	0.791	13.09	131	125.0
1528	7.06	0.75	0.792	12.99	128	149.3
1531	7.07	0.72	0.792	12.98	126	295
1534	7.07	0.71	0.792	12.85	124	226
1537	7.08	0.71	0.792	12.65	123	118.3
1540	7.07	0.71	0.791	12.50	121	110.6
1543	7.07	0.70	0.793	12.41	120	64.7
1547	7.07	0.67	0.794	12.10	115	46.8
1551	7.07	0.66	0.795	12.08	115	38.8
1555	7.07	0.65	0.794	12.12	112	28.0
1600	7.08	0.65	0.795	12.10	110	26.1
1603	7.07	0.65	0.793	12.09	110	21.3
1606	7.08	0.64	0.793	12.20	109	20.8
1609	7.08	0.62	0.793	12.30	107	19.9
1615	7.08	1.81	0.806	13.03	167	65.3

Comment: 4.0 gal removed

Well ID: MW-6 Job No: 98-478-04

Date Sampled: 10/26/2003

Sampled by: BAC

Well Diameter: 4"

DTW: 11.65

DTB: 31.8

Estimated Pump Setting: 27'

Estimated Flow Rate: 160 ml/min

Sample Collection Time: 1244

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1149	7.19	4.14	0.884	14.07	194	184.4
1152	7.18	3.36	0.889	13.59	171	142.0
1155	7.19	2.88	0.889	13.00	153	127.5
1159	7.22	2.30	0.879	13.05	128	110.0
1203	7.22	2.03	0.877	13.56	122	119.3
1207	7.24	1.38	0.870	13.71	98	117.9
1211	7.26	1.19	0.866	13.04	83	102.9
1214	7.27	1.12	0.865	13.10	80	101.4
1217	7.25	1.08	0.867	13.21	78	104.5
1220	7.24	1.05	0.874	13.18	76	114.7
1223	7.18	1.00	0.882	13.50	73	130.2
1226	7.18	0.90	0.884	13.47	71	132.1
1229	7.19	0.84	0.878	13.24	68	125.6
1232	7.20	0.80	0.875	13.11	65	118.6
1235	7.20	0.78	0.876	13.12	64	117.0
1238	7.21	0.76	0.873	13.12	63	114.6
1241	7.20	0.76	0.878	12.97	62	115.6
1250	7.21	1.03	0.863	13.34	135	135.6

Comments Removed 2.5 gal

Well ID: MW-7 Job No: 98-478-04

Date Sampled: 10/27/2003

Sampled by: BAC

Well Diameter: 4"

DTW: 6.12

DTB: 24.62

Estimated Pump Setting: 19'

Estimated Flow Rate: 210 ml/min

Sample Collection Time: 1110

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1000	6.44	1.91	4.19	14.94	157	132.5
1003	6.44	1.11	4.20	15.19	126	144.2
1006	6.43	1.08	4.19	14.85	119	145.7
1010	6.43	0.98	4.18	14.98	112	166.2
1014	6.44	0.84	4.12	15.08	103	265
1018	6.44	0.84	4.10	14.81	98	304
1022	6.45	0.82	4.06	14.52	92	376
1026	6.45	0.76	4.04	15.21	88	456
1029	6.45	0.70	3.98	15.21	82	490
1032	6.45	0.65	3.95	15.43	76	522
1035	6.46	0.64	3.95	15.40	75	516
1038	6.46	0.64	3.94	15.24	73	502
1041	6.46	0.63	3.95	15.28	69	481
1044	6.46	0.63	3.93	15.37	67	440
1047	6.46	0.60	3.92	15.53	63	405
1050	6.46	0.60	3.92	15.31	60	366
1053	6.46	0.59	3.92	14.83	58	343
1056	6.46	0.58	3.92	14.69	55	312
1059	6.46	0.56	3.93	14.71	52	293
1102	6.46	0.55	3.92	15.07	50	254
1105	6.46	0.55	3.91	14.99	49	248
1108	6.46	0.54	3.92	15.03	47	242
1115	6.46	0.67	3.91	15.45	43	136.7

Comment: 4.0 gal removed

Well ID: MW-8 Job No: 98-478-04

Date Sampled: 10/28/2003

Sampled by: BAC

Well Diameter: 4"

DTW: 8.75

DTB: 29.18

Estimated Pump Setting: 24'

Estimated Flow Rate: 190 ml/min

Sample Collection Time: 1040

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
954	7.26	2.13	1.097	14.09	16	25.3
957	7.24	1.55	1.080	14.12	23	18.0
1000	7.25	1.43	1.079	13.59	30	15.5
1003	7.25	1.31	1.076	14.05	34	12.6
1006	7.25	1.22	1.075	14.02	38	12.3
1010	7.27	1.11	1.074	14.05	41	11.6
1014	7.27	1.10	1.072	14.04	42	11.1
1018	7.26	1.03	1.058	14.06	44	9.3
1022	7.25	1.02	1.058	14.09	45	9.4
1025	7.26	0.98	1.051	13.97	45	8.9
1028	7.25	0.98	1.046	14.01	46	8.4
1031	7.23	0.92	1.033	14.12	45	6.9
1034	7.23	0.91	1.028	14.04	45	7.0
1037	7.23	0.91	1.028	13.88	45	6.9

Comment: 2.0 gal removed

Well ID: MW-9 Job No: 98-478-04

Date Sampled: 10/27/2003

Sampled by: BAC

Well Diameter: 4"

DTW: 9.74

DTB: 28.05

Estimated Pump Setting: 23"

Estimated Flow Rate: 150 ml/min

Sample Collection Time: 1220

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1137	7.02	3.21	1.004	11.73	97	31.5
1140	6.98	1.57	0.991	12.20	75	14.5
1143	6.97	1.15	0.990	12.23	62	15.0
1147	6.97	1.18	0.991	12.06	53	12.1
1151	6.97	1.15	0.991	12.05	52	13.1
1155	6.97	1.06	0.990	12.26	50	13.1
1159	6.97	0.99	0.989	12.40	50	13.7
1202	6.97	0.94	0.988	12.54	50	11.9
1205	6.97	0.91	0.987	12.61	51	13.1
1208	6.97	0.80	0.984	13.01	52	10.9
1212	6.96	0.75	0.975	13.52	56	8.8
1215	6.97	0.74	0.972	13.10	56	8.3
1218	6.97	0.70	0.967	13.52	56	7.9
1231	7.08	1.27	0.876	13.48	122	5.8

Comment: 2.0 gal removed

Well ID:	MW-10	Job No: 98-478-04
Date Sampled:	10/28/2003	
Sampled by:	BAC	
Well Diameter:	4"	
DTW:	5.36	
DTB:	22.08	
Estimated Pump Setting:	17'	
Estimated Flow Rate:	180 ml/min	
Sample Collection Time:	920	

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
831	6.65	6.35	6.58	8.75	286	23.8
834	6.75	2.31	7.59	10.31	252	13.9
837	6.74	1.42	7.57	9.83	170	13.5
840	6.74	1.34	7.54	9.74	166	13.4
844	6.74	1.19	7.49	9.88	139	16.5
848	6.73	1.06	7.29	10.08	116	20.7
851	6.73	1.03	7.18	10.14	111	18.3
854	6.73	0.96	7.07	10.20	105	18.5
857	6.73	0.90	6.97	10.02	98	19.4
900	6.73	0.88	6.92	10.00	95	18.7
903	6.73	0.84	6.89	9.99	87	18.5
906	6.73	0.82	6.87	10.01	85	17.8
909	6.73	0.81	6.78	9.95	80	16.9
912	6.73	0.77	6.77	10.14	73	16.8
915	6.73	0.76	6.73	10.22	69	16.3
918	6.73	0.74	6.69	10.23	68	15.8
923	6.73	0.83	6.55	10.72	64	25

Comment: 2.5 gal removed

Well ID:	MW-11	Job No: 98-478-04
Date Sampled:	10/27/2003	
Sampled by:	BAC	
Well Diameter:	4"	
DTW:	9.75	
DTB:	26.2	
Estimated Pump Setting:	21'	
Estimated Flow Rate:	210 ml/min	
Sample Collection Time:	915	

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
834	7.04	3.73	1.088	10.58	287	49.3
837	7.08	2.21	1.105	11.31	236	9.1
840	7.10	1.52	1.108	11.26	200	6.5
843	7.11	1.36	1.109	10.61	167	6.7
846	7.10	1.28	1.110	10.90	138	5.4
849	7.10	1.13	1.110	10.97	109	5.3
852	7.09	1.08	1.111	11.06	101	5.0
855	7.09	0.96	1.111	11.09	82	4.9
858	7.09	0.90	1.112	11.13	71	4.9
901	7.09	0.84	1.114	11.19	57	4.1
904	7.08	0.83	1.114	11.14	50	4.0
907	7.08	0.77	1.115	11.15	45	3.9
910	7.08	0.76	1.115	11.16	43	3.6
913	7.06	0.74	1.116	11.17	41	3.1
917	7.04	0.87	1.117	12.04	34	6.2

Comment: 2.5 gal removed

INORGANIC DATA VALIDATION SUMMARY

Site Name: RMC Beechgrove
Project Number: ~~98-478-04~~ 2003-1046-03
Sampling Date(s): 10/28-29/2003

Laboratory: Trimatrix
Case /Order No.: 35132-35

Compound List: ☐ TAL ☐ Priority Pollutant ☐ Appendix IX ☑ Other As & Pb

Method: ☐ CLP SOW ILMO4. ☐ 40 CFR 136 ☑ SW-846 Method 6020 ☐ Other ______

The following table indicates the data validation criteria examined, any problems identified, and the QA action applied.

Data Validation Criteria:	accept	FYI	qualify	Comments
Holding Times	✓			
Initial Calibrations	✓			
Continuing Calibrations	✓			
CRDL Standards	✓			
Blank Analysis Results		✓		
ICP Interference Check Sample Recoveries	✓			
Duplicate Results	✓			
Field Duplicate Results	✓			
Spike Analysis Recoveries	✓			
Serial Dilution Results				NA
Laboratory Control Sample Results	✓			
Furnace AA QC Analysis				NA
Quantitation/Detection Limits	✓			
Overall Assessment of Data	✓			
Other:				

General Comments: ____________________

Accept - No qualification required.
FYI - For your information only, no qualification necessary.
Qualify - Qualify as rejected, estimated or biased
NA - Not applicable.
NR - Not reviewed.

QA Scientist Jerif M Stanty
Date 1/9/2004

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/28/03 @ 12:20
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R2SED-11-0-6
Sample #: 348091
Matrix: Soil/Solid   Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	12	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	874	120	mg/kg dry	11/13/03	DSC	USEPA-6020

JMB 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/28/03 @ 12:30
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R2SED-11-6-12
Sample #: 348092
Matrix: Soil/Solid
Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	15	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	1470	300	mg/kg dry	11/13/03	DSC	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/28/03 @ 12:45
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R2SED-12-0-6
Sample #: 348093
Matrix: Soil/Solid   Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	11	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	411	60	mg/kg dry	11/13/03	DSC	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/28/03 @ 12:50
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R2SED-12D-0-6
Sample #: 348094
Matrix: Soil/Solid   Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	12	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	462	60	mg/kg dry	11/13/03	DSC	USEPA-6020

JMB 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/28/03 @ 12:55
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R2SED-12-6-12
Sample #: 348095
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	9.3	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	32	0.60	mg/kg dry	11/11/03	JMF	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

ANALYTICAL REPORT

Client: Advanced GeoServices Corporation
Project: RMC - Beech Grove, IN

Sampled: 10/28/03 @ 13:05
Sampler:
Received: 10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R2SED-13-0-6
Sample #: 348096
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	12	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	771	120	mg/kg dry	11/13/03	DSC	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/28/03 @ 13:20
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: **35132-35**
Submittal: October 2003 Soil Samples

Sample ID: **R2SED-13-6-12**
Sample #: **348097**
Matrix: Soil/Solid   Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	8.3	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	28	0.60	mg/kg dry	11/11/03	JMF	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/28/03 @ 13:40
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R2SED-14-0-6
Sample #: 348098
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	11	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	681	60	mg/kg dry	11/13/03	DSC	USEPA-6020

JMD 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/28/03 @ 13:55
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R2SED-14-6-12
Sample #: 348099
Matrix: Soil/Solid
Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	9.5	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	24	0.60	mg/kg dry	11/11/03	JMF	USEPA-6020

JMB 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/28/03 @ 14:20
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: EB-3-102803
Sample #: 348100
Matrix: QC Water

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	<1.0	1.0	ug/L	11/12/03	MSG	EPA-200.8/6020
Lead, Total	<1.0	1.0	ug/L	11/12/03	MSG	EPA-200.8/6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/29/03 @ 08:45
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B30-0-3
Sample #: 348101
Matrix: Soil/Solid — Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	12	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	1810	300	mg/kg dry	11/13/03	DSC	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client: Advanced GeoServices Corporation
Project: RMC - Beech Grove, IN

Sampled: 10/29/03 @ 08:50
Sampler:
Received: 10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B30-3- 10
Sample #: 348102
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	9.0	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	479	60	mg/kg dry	11/13/03	DSC	USEPA-6020

JMB 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix
Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/29/03 @ 09:10
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B29-0-3
Sample #: 348103
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	154	25	mg/kg dry	11/13/03	DSC	USEPA-6020
Lead, Total	14800	3000	mg/kg dry	11/13/03	DSC	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client: Advanced GeoServices Corporation
Project: RMC - Beech Grove, IN

Sampled: 10/29/03 @ 09:15
Sampler:
Received: 10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B29-3- 10
Sample #: 348104
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	216	25	mg/kg dry	11/13/03	DSC	USEPA-6020
Lead, Total	15700	3000	mg/kg dry	11/13/03	DSC	USEPA-6020

gms
1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/29/03 @ 09:40
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B25-0-3
Sample #: 348105
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	23	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	617	60	mg/kg dry	11/13/03	DSC	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/29/03 @ 09:50
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B25-3- 10
Sample #: 348106
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	17	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	425	60	mg/kg dry	11/13/03	DSC	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/29/03 @ 10:10
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B26-0-3
Sample #: 348107
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	169	25	mg/kg dry	11/13/03	DSC	USEPA-6020
Lead, Total	12200	1200	mg/kg dry	11/13/03	DSC	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client: Advanced GeoServices Corporation
Project: RMC - Beech Grove, IN

Sampled: 10/29/03 @ 10:20
Sampler:
Received: 10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B26-3- 10
Sample #: 348108
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	114	25	mg/kg dry	11/13/03	DSC	USEPA-6020
Lead, Total	6020	600	mg/kg dry	11/13/03	DSC	USEPA-6020

JMB 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/29/03 @ 10:30
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B27-0-3
Sample #: 348109
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	25	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	786	120	mg/kg dry	11/13/03	DSC	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

ANALYTICAL REPORT

Client: Advanced GeoServices Corporation
Project: RMC - Beech Grove, IN

Sampled: 10/29/03 @ 10:40
Sampler:
Received: 10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B27-3- 10
Sample #: 348110
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	35	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	658	120	mg/kg dry	11/13/03	DSC	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client:	Advanced GeoServices Corporation	Sampled:	10/29/03 @ 11:00
Project:	RMC - Beech Grove, IN	Sampler:	
		Received:	10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B28-0-3
Sample #: 348111
Matrix: Soil/Solid   Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	23	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	684	120	mg/kg dry	11/13/03	DSC	USEPA-6020

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

ANALYTICAL REPORT

Client: Advanced GeoServices Corporation
Project: RMC - Beech Grove, IN

Sampled: 10/29/03 @ 11:05
Sampler:
Received: 10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B28-3- 10
Sample #: 348112
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	20	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	403	60	mg/kg dry	11/13/03	DSC	USEPA-6020

JMB 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

TriMatrix Laboratories, Inc.

ANALYTICAL REPORT

Client: Advanced GeoServices Corporation
Project: RMC - Beech Grove, IN

Sampled: 10/29/03 @ 11:10
Sampler:
Received: 10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: R25B28D-3-10
Sample #: 348113
Matrix: Soil/Solid

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	22	1.0	mg/kg dry	11/11/03	JMF	USEPA-6020
Lead, Total	490	60	mg/kg dry	11/13/03	DSC	USEPA-6020

JMB 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

ANALYTICAL REPORT

Client: Advanced GeoServices Corporation
Project: RMC - Beech Grove, IN

Sampled: 10/29/03 @ 11:30
Sampler:
Received: 10/31/03 @ 09:00

Submittal #: 35132-35
Submittal: October 2003 Soil Samples

Sample ID: EB-4-102903
Sample #: 348114
Matrix: QC Water

Percent Solids: n/a

Parameter	Analytical Result	Reporting Limit	Unit	Analysis Date	Chem	Reference Citation
Arsenic, Total	<1.0	1.0	ug/L	11/12/03	MSG	EPA-200.8/6020
Lead, Total	<1.0	1.0	ug/L	11/12/03	MSG	EPA-200.8/6020

JMB 1/9/2004

End of Analytical Report

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

Blank Contamination

Blank ID	Batch No.	Analyte	Conc. (mg/kg)	Conc * 5	Associated Samples	Sample Conc. (mg/kg)
MPB	90840-105	Lead	0.64	3.2	R25B27-3-10	658
					R25B28-0-3	684
					R25B28-3-10	403
					R25B28D-3-10	490

MB 1/9/2004

Blanks.xls/35132-35

TriMatrix Laboratories, Inc.

QUALITY CONTROL REPORT
BLANKS
USEPA CLP FORM 3

SDG No. 35132 -35 Parameter Lead, Total
Instrument ID 201

Batch Number	Blank Type		Amount Found	Quant. Limit	Reference Citation	Matrix	Units
209224	BLK	1	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209224	ICB	1	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209224	CCB	1	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209224	CCB	2	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209224	CCB	3	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209224	CCB	4	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209246	BLK	1	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209246	ICB	1	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209246	CCB	1	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209246	CCB	2	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209246	CCB	3	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209246	CCB	4	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209246	CCB	5	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209303	BLK	1	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209303	ICB	1	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209303	CCB	1	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209303	CCB	2	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209303	CCB	3	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
209303	CCB	4	<1.0	1.0	EPA-200.8/6020	WATER	ug/L
90838-105	MPB	1	<0.60	0.60	USEPA-6020	SOIL	mg/kg dry
90840-105	MPB	1	0.64	0.60	USEPA-6020	SOIL	mg/kg dry
90843-104	MPB	1	<1.0	1.0	EPA-200.8/6020	WATER	ug/L

Associated Samples

R25B27-3-10
R25B28-0-3
R25B28-3-10
R25B28D-3-10

JMS 1/9/2004

5560 Corporate Exchange Court SE • Grand Rapids, MI 49512 • (616) 975-4500 • Fax (616) 942-7463

Site Name: RMC Beech Grove   Laboratory: Trimatrix

Project Number: 2003-1046-03

Field Duplicates

Sample ID	Analyte	Units	Result	RPD	Qualifier
R2SED-12-0-6	Arsenic	mg/kg	11		
R2SED-12D-0-6		mg/kg	12	8.70	
	Lead	mg/kg	411		
		mg/kg	462	11.68	
R25B28-3-10	Arsenic	mg/kg	20		
R25B28D-3-10		mg/kg	22	9.52	
	Lead	mg/kg	403		
		mg/kg	490	19.48	

Duplicate Criteria: Soil/Solid matrices <40 %RPD for samples with results > EQL

* - Denotes %RPD outside criteria.

NA - Duplicate relative percent difference cannot be calculated.

ND - Not detected.

JMD 1/9/2004

Fdup.xls/35132-35

ATTACHMENT 2

Baseline Human Health Risk Assessment for

Refined Metals Corporation Facility

Beech Grove, Indiana

Conducted as Part of the

Phase I Corrective Measures Study

Prepared for
Refined Metals Corporation
3000 Montrose Ave.
Reading, PA 19605-2751

Prepared by
Gradient Corporation
20 University Road
Cambridge, MA 02138

October 5, 2004

Table of Contents

Page

1 Introduction

1.1 Site Description and History

The Refined Metals Corporation (RMC) facility is located at 3700 South Arlington Avenue in Beech Grove, Indiana. Secondary lead smelting and refining operations were conducted at this site from 1968 to the end of 1995.

The site occupies approximately 24 acres, of which approximately 10 acres represented the active manufacturing area (including paved areas and buildings). The remaining 14 acres includes grassed and wooded site areas. The site is bordered by Arlington Avenue to the east, a natural gas facility (Citizen's Gas) to the west, a railroad to the north, and Big Four Road to the south (Figure 1). The site is relatively flat with less than 10 feet of total relief. Natural site drainage is toward the north and east. The former manufacturing area is almost completely paved, and is characterized by nearly 80,000 square feet of structures consisting of the battery breaker, a wastewater treatment plant, material storage areas, a blast furnace, a dust furnace, a metals refining area, warehouse and offices.

The RMC facility was divided into two exposure areas for the purpose of this evaluation: the fenced facility area consisting of the plant buildings and surrounding paved areas; and the grassy areas to the north, east, and south of the paved facility area. The Citizen's Gas property to the west was evaluated as a separate exposure area.

1.2 Previous Investigations

On July 14, 1998, RMC entered into a Consent Decree with the United States Environmental Protection Agency (USEPA) and the Indiana Department of Environmental Management (IDEM). Under this Consent Decree, a RCRA Facility Investigation (RFI) was performed to evaluate and determine the nature and extent of releases and to collect information necessary to support human health and ecological risk assessments so that a Corrective Measures Study may be implemented. Pursuant to Section VI, Paragraph 42 of the Consent Decree (Compliance Requirements for Corrective Action), Advanced GeoServices Corp. (AGC) performed the RFI in accordance with an approved RFI work plan on behalf of RMC. The preparation and implementation of the RFI work plans were enacted in accordance with Exhibit B of the Consent Decree and the EPA's RCRA Facility Investigation Guidance Document (EPA 530/SW-89-031). The RFI was conducted in multiple phases. The results from the initial phase of sampling were presented in the Phase I RFI Report dated August 31, 2000 (AGC, 2000). Based on the results of the Phase I RFI a Phase II RFI Work Plan was submitted to the EPA on December 20, 2000. In response to comments on the Phase II RFI Work Plan issued by the EPA on April 3, 2001, revisions to the Phase II RFI Work Plan were submitted to the EPA on June 27, 2001. The EPA approved the Phase II RFI Work Plan on July 13, 2001, the results of which were contained in the Phase II RFI Report dated November 18, 2002 (AGC, 2002). Additional site sampling was conducted during a closure investigation to address three former RCRA-regulated solid waste managements units (SWMUs). The results of the SWMU closure investigation were presented by AGC in the Closure Investigation Report dated June 1, 2001.

1.3 Report Objectives and Organization

This report presents the results of the baseline human health risk assessment (HHRA) that was conducted to evaluate potential human health risks in each exposure area. The purpose of this evaluation is to determine whether these areas pose any significant health risks or if they require remediation to reduce risk to acceptable levels.

The remainder of this report is organized in the following sections. Section 2 discusses the data used in the risk assessment, and the constituents of potential concern. Section 3 discusses the potential receptors, exposure media, and exposure pathways for each exposure area. Section 4 presents the toxicity assessment. Section 5 presents the risk characterization. Section 6 presents soil lead cleanup levels. Section 7 presents the conclusions for all scenarios evaluated.

2 Constituents of Potential Concern

The results of the Phase I RFI indicated that lead and arsenic are the main contaminants of concern in soil, both onsite and offsite. Lead and arsenic were detected in soil samples from the site at concentrations above both residential and industrial risk-based concentrations (RBCs). The baseline risk assessment retained lead and arsenic as COPCs in soil.

3 Exposure Assessment

3.1 Potential Receptors and Exposure Pathways

The potential receptors, exposure media, exposure pathways, and exposure frequencies evaluated in each exposure area are presented in Table 1, and are discussed in more detail below. Exposure Areas are shown in Figure 1.

Table 1
Receptors and Exposure Pathways

Exposure Area	Media	Soil Depth	Exposure Pathways	Receptors	Exposure Frequency (days/year)	Exposure Duration (years)
Plant Area	Subsurface soil	0-5 ft	Ingestion, Dermal Contact	Construction Worker	50	5
Plant Area	Subsurface soil	0-5 ft	Ingestion, Dermal Contact	Utility Worker	10	10
North, South, and East Grassy Areas	Surface soil	0-6"	Ingestion, Dermal Contact	Groundskeeper	50	25
				Adolescent Trespasser	25	5
				Future Site Worker	144	25
Off Site Natural Gas Facility	Surface soil	0-6"	Ingestion, Dermal Contact	Adult Worker (30 yr)	225	25

3.1.1 Facility Area

The plant buildings and surrounding paved areas occupy approximately the central third of the RMC property. The site is largely paved – the only exposed surface soil is limited to a strip along the western fence line. In this exposure area, we evaluated a utility worker and a construction worker who could be exposed to subsurface soil. Both the utility and construction worker are assumed to be exposed to subsurface soil at depths from 0 to 5 feet, *via* incidental ingestion and dermal contact. The utility worker is assumed to have an exposure frequency of 10 days/year and an exposure duration of 10 years. The construction worker is assumed to have an exposure frequency of 50 days/year for 5 years.

3.1.2 Grassy Areas North, South, and East of Main Facility

The grassy and wooded areas located north, south, and east of the main facility encompass approximately the northern and southern thirds of the RMC property (Figure 1). The receptors evaluated in both of these areas include an adolescent trespasser and an adult groundskeeper under current use, and a future site worker. These receptors are assumed to be exposed to surface soil *via* incidental ingestion and dermal contact. The adolescent trespasser (age 13-18 years) is assumed to have an exposure frequency of 25 days/year and an exposure duration of 5 years. The groundskeeper is assumed to have an exposure frequency of 50 days/year and an exposure duration of 25 years. A future site worker is assumed to spend most of his time in the plant and surrounding paved areas. However, he may have occasion to visit the grassy/wooded areas for a walk or to eat lunch at a picnic table. The future site worker is assumed to have an exposure frequency in these areas of 4 days/week for 36 weeks/year or 144 days/year, and an exposure duration of 25 years.

3.1.3 Offsite Natural Gas Facility

At the offsite natural gas facility, an adult commercial worker was evaluated. The worker is assumed to be exposed to surface soil *via* incidental ingestion and dermal contact. The worker is assumed to have an exposure frequency in these areas of 5 days/week for 45 weeks/year, or 225 days/year, and an exposure duration of 25 years.

3.2 Exposure Point Concentrations

In a risk assessment, an Exposure Point Concentration (EPC) represents the concentration of a chemical in an environmental medium to which an individual is exposed. The calculation of EPCs is described below. The EPCs used in this risk evaluation are presented in Table 2.

Table 2
Exposure Point Concentrations

Exposure Area	Medium	Depth	Arsenic EPC mg/kg	Arsenic Basis 95%UCL	Lead EPC mg/kg	Lead Basis
Plant Area	Subsurface Soil	0-5 ft	123	NP, bootstrap	20,266	arithmetic mean
Grassy Area	Surface Soil	0-6 in	312	NP, bootstrap	15,916	arithmetic mean
Offsite Natural Gas Facility	Surface Soil	0-6 in	28.5	LN, H-UCL	1,311	arithmetic mean

NP Nonparametric
LN Lognormal

For arsenic, the EPCs were the 95% upper confidence level on the mean (95UCL) concentration. The 95UCL is used instead of the mean or arithmetic average because it is not possible to know the true mean (USEPA, 1992b). The 95UCL is defined as a value that ..."equals or exceeds the true mean 95% of the time" (USEPA, 1992b). As sampling data become more representative of actual site conditions, uncertainties decrease, and the 95UCL approaches the true mean. The 95UCL values were calculated with ProUCL© according to USEPA guidance (USEPA, 2002a).

To evaluate lead risks, the arithmetic mean soil lead concentration within the exposure area was used as the EPC to be consistent with USEPA guidance (USEPA, 1994; USEPA, 1996)

3.3 Quantification of Exposure

This section discusses the basis for calculating human intake levels resulting from exposures to COPCs other than lead (in this case arsenic), and describes each input parameter. Human intake levels for lead are discussed in Section 5. Exposure estimates represent the daily dose of a chemical taken into the body, averaged over the appropriate exposure period, expressed in the units of milligram (mg) of chemical per kilogram (kg) of human body weight per day. The primary source for the exposure equations used in the HHRA is the USEPA's "*Risk Assessment Guidance for Superfund* (RAGS)" (USEPA, 1989).[1] The generalized equation for calculating chemical intakes is shown below:

$$I = \frac{EPC \times CR \times EF \times ED}{BW \times AT}$$

[1] Note that this approach is not used to evaluate lead. Consistent with USEPA guidance, lead exposure is evaluated using a child or adult lead model to estimate blood lead levels.

where:

I	=	Intake, the amount of chemical at the exchange boundary (mg/kg body weight-day),
EPC	=	Exposure Point Concentration, the chemical concentration contacted over the exposure period at the exposure point (*e.g.*, mg/kg in soil),
CR	=	Contact Rate, the amount of contaminated medium contacted per unit time or event (*e.g.*, soil ingestion rate (mg/day)),
EF	=	Exposure Frequency, describes how often exposure occurs (days/year),
ED	=	Exposure Duration, describes how long exposure occurs (yr),
BW	=	Body Weight, the average body weight over the exposure period (kg), and
AT	=	Averaging Time, period over which exposure is averaged (days).

Exposure factors (*e.g.*, contact rate, exposure frequency, exposure duration, body weight) describe a receptor's exposure for a given exposure scenario. The values used for each exposure factor are summarized in Table 3 and discussed in detail below. The exposure factor input values are consistent with current USEPA guidance. Where appropriate, exposure parameters were based on site-specific considerations and professional judgment.

Table 3
Summary of Exposure Factor Input Values

Exposure Area / Receptor	Onsite Construction Worker	Onsite Utility Worker	Grassy Area Site Worker	Grassy Area Grounds-keeper	Grassy Area Adolescent Trespasser	Offsite Gas Facility Worker
Exposure Pathway/Exposure Factor						
Ingestion of Soil						
Ingestion Rate (mg/day)	330	330	50	100	50	50
Exposure Duration (yr)	5	10	25	25	5	25
Exposure Frequency (days/yr)	50	10	144	50	25	225
Body Weight (kg)	70	70	70	70	58	70
Bioavailability (arsenic)	0.8	0.8	0.8	0.8	0.8	0.8
Conversion Factor (kg/mg)	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001
Fraction from Contaminated Source	1	1	1	1	1	1
Averaging Time (days) – Cancer	25550	25550	25550	25550	25550	25550
Averaging Time (days) - Non Cancer	365	3650	9125	9125	1825	9125
Dermal Contact with Soil						
Dermal Absorption Factor (arsenic)	0.03	0.03	0.03	0.03	0.03	0.03
Soil Adherence Factor (mg/cm^2)	0.2	0.2	0.07	0.2	0.07	0.2
Surface Area (cm^2/d)	3300	3300	3300	3300	4270	3300
Exposure Duration (years)	5	10	25	25	5	25
Exposure Frequency (days/yr)	50	10	144	50	25	225
Body Weight (kg)	70	70	70	70	58	70
Conversion Factor (kg/mg)	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001
Fraction from Contaminated Source	1	1	1	1	1	1
Averaging Time (days) - Cancer	25550	25550	25550	25550	25550	25550
Averaging Time (days) - Non Cancer	365	3650	9125	9125	1825	9125

3.3.1 Ingestion of Soil

For the soil ingestion pathway intake is calculated as:

$$Intake\left(\frac{mg}{kg \cdot day}\right) = \frac{C_{soil}\left(\frac{mg}{kg}\right) \times B \times IR_{soil}\left(\frac{mg}{day}\right) \times FS \times EF\left(\frac{days}{yr}\right) \times ED(yrs) \times 10^{-6}\,\frac{kg}{mg}}{BW(kg) \times AT(days)}$$

where:

C_{soil}	=	Concentration of the chemical in soil (mg/kg)
B	=	Relative Bioavailability, the relative oral absorption fraction (unitless)
IR_{soil}	=	Soil Ingestion Rate (mg/day)
FS	=	Fraction of Soil from the site (unitless)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)

Gradient used conservative USEPA-recommended values for each of the input parameters. The basis for each value used is detailed below.

Soil Concentrations (C_{soil}). As summarized in Section 3.2, the 95UCL was used as the EPC.

Relative Bioavailability (B). To accurately quantify potential exposures from ingestion of soil, it is important to consider the amount of a chemical that is solubilized in gastrointestinal fluids and absorbed across the gastrointestinal tract into the bloodstream. A chemical present in soil may be absorbed less completely than the same dose of the chemical administered in toxicity studies used to evaluate safe dose levels. A relative bioavailability estimate for a specific compound represents the absorption fraction from soil (the exposure route of concern) relative to the absorption fraction from food or water (in most toxicity studies, chemical doses are administered in food or water).

It is widely recognized that bioavailability of many metals and organics from soil tends to be considerably lower than bioavailability from food or water. USEPA guidance recognizes the need to make adjustments for the reduced bioavailability of compounds in soil. Specifically, in Appendix A of USEPA's Risk Assessment Guidance for Superfund (USEPA, 1989, pg. A-3), USEPA notes:

> If the medium of exposure in the site exposure assessment differs from the medium of exposure assumed by the toxicity value (*e.g.*, RfD values usually are based on or have been adjusted to reflect exposure *via* drinking water, while the site medium of concern may be soil), an absorption adjustment may, on occasion, be appropriate. For example, a substance might be more completely absorbed following exposure to contaminated drinking water than following exposure to contaminated food or soil (*e.g.*, if the substance does not desorb from soil in the gastrointestinal tract).

USEPA Region 10 risk assessment guidance provides default values for the bioavailability of arsenic in soil. Region 10 notes that if the site is a smelter site and its appears likely that the arsenic exists primarily as finely-grained oxides from smelter stack emissions, then a value of 80% relative bioavailability may be assumed. Region 10 notes that this value is supported by a conservative interpretation of the scientific literature (USEPA Region 10, 1997). A relative bioavailability of 80% was used for arsenic in this risk assessment.

For lead, the USEPA recommends an oral absorption factor for adults of 0.12 for ingestion of lead in soil, based on 20% absorption of soluble lead, and a relative bioavailability of 60% for lead in soil (*i.e.*, $0.12 = 0.2 \times 0.6$) (USEPA, 1996). Gradient used the recommended USEPA absorption factor of 0.12 to evaluate ingestion of lead contaminated soil for adult receptors.

Soil Ingestion Rate (IR_{soil}). A daily soil and dust ingestion rate of 50 mg/day was used for the adolescent trespasser, site worker, and offsite gas facility worker. USEPA considers this value to be a reasonable central estimate of adult soil ingestion and notes that although this value is highly uncertain, "a recommendation for an upper percentile value would be inappropriate" (USEPA, 1997a). A daily soil and dust ingestion rate of 100 mg/day was used for the groundskeeper (USEPA, 2002b). A daily soil and dust ingestion rate of 330 mg/day was used for the onsite construction worker and the onsite utility worker, as these receptors are assumed to have more intensive contact with soil than the other adult receptors (USEPA, 2002b).

Fraction of Soil From the Site (FS). For all receptors, it was assumed that 100% of the individual's daily soil exposure occurred at the site. This assumption is likely to overestimate exposure to contaminated soil for workers and trespassers because workers are assumed to be at the site for only 8 hours per day, and trespassers are likely present less than 2 hours per visit.

Exposure Frequency (EF) and Exposure Duration (ED). The exposure frequency and duration used for each receptor are discussed in Section 3.1.1 to 3.1.3. For the site worker, groundskeeper, and offsite gas worker, the exposure duration is 25 years. This is the 95th percentile duration that an individual stays at any one workplace (USEPA, 1991). Hence, this assumption overestimates exposures for most workers, because the median occupational tenure of the working population has been estimated to be 6.6 years (USEPA, 1997a).

Body Weight (BW). Although the average U.S. adult body weight in the current Exposure Factors Handbook (USEPA, 1997a) is 71.8 kg, a mean adult body weight of 70 kg (USEPA, 1991) was used in the HHRA, so that the body weight would be consistent with that used in deriving the toxicity factors. Average body weight for the adolescent trespasser (13-18 year old) was calculated from data in USEPA's Exposure Factors Handbook and used in the HHRA (USEPA, 1997a).

Averaging Time (AT). For non-cancer risks, the averaging time was equal to the exposure duration multiplied by 365 days/year. For cancer risks, exposures were averaged over a 70-year average lifetime (USEPA, 1991). Although the current life expectancy for men and women in the U.S. is 76.7 years (USEPA, 1997a), a value of 70 years (25,550 days) was used to be consistent with the value used in deriving the toxicity factors.

3.3.2 Dermal Contact with Surface Soil

For dermal exposure to contaminants in soil, a dermal intake (the amount absorbed into the body) is calculated as (USEPA, 2004c):

$$Intake\left(\frac{mg}{kg \cdot day}\right) = \frac{C_{soil}\left(\frac{mg}{kg}\right) \times DA \times AF\left(\frac{mg}{cm^2}\right) \times SA\left(\frac{cm^2}{event}\right) \times EF\left(\frac{events}{yr}\right) \times ED(yrs) \times 10^{-6}\,\frac{kg}{mg}}{BW(kg) \times AT(days)}$$

where:

C_{soil}	=	Concentration of the chemical in soil (mg/kg),
DA	=	Dermal Absorption factor (unitless)
AF	=	Soil/skin Adherence Factor (mg/cm^2),
SA	=	Skin surface Area exposed (cm^2/exposure event),
EF	=	Exposure Frequency (exposure events/year),
ED	=	Exposure Duration (years),
BW	=	Body Weight (kg), and
AT	=	Averaging Time (days).

There are three parameters in this equation that are different from those discussed in the previous section (Section 3.3.1). Only those parameters unique to the dermal exposure equation, dermal absorption fraction (DA), the soil adherence factor (AF), and the skin surface area (SA), are discussed in this section.

Note that since absorbed doses are used for the dermal pathway, the toxicity criteria are adjusted so they apply to absorbed doses. This adjustment is discussed in more detail in the toxicity section (Section 4).

Dermal Absorption Fraction (DA). The dermal absorption fraction represents the amount of a chemical in contact with skin that is absorbed through the skin and into the bloodstream. The dermal absorption fraction for arsenic (0.03) was obtained from USEPA's dermal risk assessment guidance (USEPA, 2004c; Table 3.4).

Soil to Skin Adherence Factor (AF). The adherence factor relates the amount of soil that adheres to the skin per unit of surface area (USEPA, 2004c). Adherence factors vary depending on the properties of the soil, the part of the body, and the type of activity. Gradient used the 50^{th} percentile weighted adherence factors from USEPA's dermal risk assessment guidance (USEPA, 2004c). The AF for utility workers (0.2 mg/cm^2) was used for the construction worker, utility worker, groundskeeper, and offsite gas facility worker. EPA's recommended AF for the residential adult (0.07 mg/cm^2) was used for the future site worker and the adolescent trespasser.

Skin Surface Area Exposed (SA). This parameter reflects the amount of skin that is available for exposure to soil. The skin surface areas used in the HHRA were 3300 cm^2 for the construction worker, utility worker, site worker, groundskeeper, and offsite gas facility worker, based on the face, hands, and forearms; and 4270 cm^2 for the trespasser, based on the face, hands, forearms, and lower legs. Surface areas were calculated using USEPA's Exposure Factors Handbook (USEPA, 1997a).

4 Toxicity Assessment

4.1 Overview of Toxicity Values

Gradient has evaluated potential cancer and non-cancer risks from exposure to arsenic using dose-response relationships for carcinogenicity (oral Cancer Slope Factors) and systemic toxicity (oral Reference Doses). Lead toxicity is discussed separately in Section 4.2. The primary source of toxicity values was the USEPA's Integrated Risk Information System (IRIS) (USEPA, 2004a). Toxicity values in IRIS undergo a rigorous peer review process and are generally considered to be of high quality. The toxicity factors used in the HHRA are summarized in Table 4-1.

Table 4
Toxicity Factors

Compound	RfD_{oral} (mg/kg-day)	Critical Effect	RfD Source	Uncertainty Factor	Oral Absorption	RfD_{dermal} (mg/kg-day)	CSF_{oral} (mg/kg-day)	CSF_{dermal} (mg/kg-day)
Arsenic	0.0003	Hyperpigmentation, keratosis and possible vascular complications	IRIS	3	95%	0.0003	1.5	1.5

4.1.1 Oral Reference Doses (RfD_{oral})

An RfD is an estimate of daily exposure that a sensitive population can experience over a lifetime with a negligible risk of systemic health effects. The USEPA derives RfDs by first identifying the highest dose level that does not cause observable adverse effects (*i.e.*, the No Observed-Adverse Effect Level, or NOAEL; USEPA, 1993). If a NOAEL was not identified, a Lowest Observed Adverse Effect-Level, or LOAEL, may be used. This dose level is then divided by uncertainty factors to calculate an RfD. An uncertainty factor of 100 is often used, to account for interspecies differences (if animal studies were used) and sensitive human subpopulations (*e.g.*, children and the elderly; USEPA, 1993). Additional uncertainty factors may be used, depending on the quality of the toxicological data.

4.1.2 Oral Cancer Slope Factors (CSF_{oral})

The CSF is an upper bound estimate of carcinogenic potency used to calculate risk from exposure to carcinogens, by relating estimates of lifetime average chemical intake to the incremental risk of an individual developing cancer over their lifetime (USEPA, 1992c). The CSFs recommended by the USEPA are conservative upper bound estimates, which means that the USEPA is reasonably confident that the "true" cancer risk does not exceed the estimated risk calculated using the CSF, and may be as low as zero.

4.1.3 Dermal Reference Doses (RfD_{dermal})

There are no USEPA-derived toxicity values based specifically on toxicity studies involving dermal exposures. In the absence of dermal-specific RfDs, oral toxicity factors are used, assuming that once a chemical is absorbed into the blood stream, the health effects are similar regardless of whether the route of exposure is oral or dermal. However, since oral toxicity criteria are based on the amount of a chemical *administered* per unit time and body weight (chemical intake), they need to be adjusted to be applicable to *absorbed* doses (dermal exposures are expressed as absorbed intake levels) (USEPA, 1989; 1992a; 2004c).

Since most RfDs are based on studies where a chemical is administered in food or water, this adjustment is made using the oral absorption efficiency for that chemical. If oral absorption is very high (almost 100%), then the absorbed dose is virtually the same as the administered dose, and no adjustment of the toxicity factor is necessary. If oral absorption is very low (*e.g.*, 5%), the absorbed dose is much smaller than the administered dose, and an adjustment of the toxicity criteria is necessary. For any given chemical, the USEPA recommends adjusting the oral toxicity factor for use in evaluating dermal risks only when the oral absorption for that chemical is less than 50%, to "obviate the need to make comparatively small adjustments in the toxicity value that would otherwise impart on the process a level of accuracy that is not supported by the scientific literature" (USEPA, 2004c).

For non-cancer effects, this adjustment is made by multiplying the oral RfD (for applied doses) by the oral absorption efficiency (*i.e.*, $RfD_{oral} \times Abs_{oral} = RfD_{dermal}$). For arsenic, the oral absorption efficiency is 95%, therefore no adjustment is necessary and the RfD_{dermal} is the same as the RfD_{oral} (Table 4).

4.1.4 Dermal Cancer Slope Factors (CSF_{dermal})

There are no USEPA-derived toxicity values specifically for cancer studies involving dermal exposures. In the absence of dermal-specific CSFs, oral CSFs are used, assuming that once a chemical is absorbed into the blood stream, the carcinogenic effect is similar regardless of whether the route of exposure is oral or dermal. However, since oral CSFs are based on the amount of a chemical *administered* per unit time and body weight (chemical intake), they need to be adjusted to be applicable to *absorbed* doses (dermal exposures are expressed as absorbed intake levels) (USEPA, 1989; 1992a; 2004c). For any given chemical, the USEPA recommends adjusting the oral CSF for use in evaluating dermal risks only when the oral absorption for that chemical is less than 50%, to "obviate the need to make comparatively small adjustments in the toxicity value that would otherwise impart on the process a level of accuracy that is not supported by the scientific literature" (USEPA, 2004c).

For cancer, this adjustment is made by dividing the oral CSF (for applied doses) by the oral absorption efficiency (*i.e.*, CSF_{oral} / Abs_{oral} = CSF_{dermal}), if the oral absorption efficiency is less than 50%. For arsenic, this value is 95%, therefore the CSF_{dermal} is the same as the CSF_{oral} (Table 4).

4.2 Toxicity Values for COPCs

The basis of the arsenic toxicity values is described in this section and summarized in Table 4. Lead toxicity is also discussed in this section because of the unique way exposure and risk are evaluated for this metal.

4.2.1 Arsenic

The toxicity criteria for arsenic were obtained from the USEPA IRIS database (USEPA, 2004a). The derivation of each of these values, and the scientific uncertainties concerning arsenic toxicity, are discussed below.

4.2.1.1 Arsenic RfD_{oral}

USEPA cites an RfD_{oral} for arsenic of 0.0003 mg/kg-day (USEPA, 2004a). The arsenic RfD_{oral} is based on increased incidence of hyperpigmentation, keratosis and possible vascular complications in a study of a large population (over 40,000 people) in Taiwan with chronic exposure to arsenic in drinking water and food (Tseng, 1977; Tseng *et al.*, 1968). The USEPA characterized a NOAEL of 0.0008 mg/kg/day for skin lesions in the Tseng study, based on the drinking water concentration in the NOAEL group (0.009 mg/L), an assumed drinking water ingestion rate of 4.5 L, daily arsenic intake from sweet potatoes and rice of 0.002 mg/day, and an average Taiwanese body weight of 55 kg ((0.009 mg/L × 4.5

L/day) + 0.002 mg/day / 55 kg) (Abernathy *et al.*, 1989). An uncertainty factor of 3 (based on the lack of reproductive toxicity data and uncertainty regarding toxicity in sensitive individuals) was applied to the NOAEL to derive an RfD of 0.0003 mg/kg/day (0.0008/3). Overall, the USEPA has "medium" confidence in the study, "medium" confidence in the database (due to poor characterization of the dose levels in the Tseng and other supporting studies), and "medium" confidence in the RfD_{oral} for arsenic. It is noted in the arsenic IRIS file that a clear consensus does not exist among USEPA scientists regarding arsenic systemic toxicity (USEPA, 2004a).

4.2.1.2 Arsenic CSF_{oral}

USEPA concluded that arsenic is a "human carcinogen," a weight-of-evidence classification for carcinogenicity of "A" (USEPA, 2004a). This classification is based on sufficient evidence of carcinogenicity in human populations. Lung cancer has been associated with inhalation of arsenic, and skin, bladder, and possibly other internal cancers have been associated with ingestion of arsenic in drinking water.

In IRIS, the USEPA recommends a CSF_{oral} value for arsenic of 1.5 $(mg/kg/day)^{-1}$ (USEPA, 2004a). This value is based on skin cancer incidence rates in the same Taiwanese study used as the basis for the RfD_{oral} value (Tseng, 1977; Tseng *et al.*, 1968). This value was calculated using a multistage model, assuming a drinking water ingestion rate of 3.5 L/day for Taiwanese males and 2 L/day for Taiwanese females, an average Taiwanese body weight of 55 kg, and an average U.S. body weight of 70 kg.

There is currently considerable debate among the scientific community regarding the arsenic CSF_{oral}. Many researchers believe that the current value of 1.5 $(mg/kg/day)^{-1}$ may overestimate cancer risks for U.S. populations (see, for example, Slayton *et al.*, 1996; Chappell *et al.*, 1997).

4.2.1.3 Arsenic RfD_{derm} and CSF_{derm}

In general, for dermal exposures (expressed as absorbed intake levels), the RfD_{oral} and CSF_{oral} are adjusted to be applicable to absorbed doses (USEPA, 1989; 1992a). This adjustment is made assuming that once a chemical is absorbed into the blood stream, the health effects are similar regardless of whether the route of exposure is oral or dermal. However, since oral absorption for arsenic is about 95%

(USEPA, 2004c), and the USEPA recommends adjusting dermal toxicity factors only when oral absorption is less than 50%, no adjustment was made for arsenic.

4.2.2 Lead

The ingestion of lead at certain levels can result in significant health effects, particularly among children. Epidemiological investigators have reported a correlation between blood lead levels (BLLs) in children and adverse health effects. High levels of lead intake can cause kidney damage, convulsions, coma, and even death (ATSDR, 1999). However, health effects resulting from lower levels of lead exposure are more common, and are related to cognitive and neuro-behavior impacts, including the impairment of intellectual performance.

The USEPA has not established any toxicity criteria (RfD, CSF) for lead (USEPA, 2004b); instead, lead risks are evaluated by modeling blood lead levels. Lead risks in adults were evaluated using USEPA's Adult Lead Model (USEPA, 2003). This model is discussed in more detail in Section 5.4.

The USEPA has assigned lead a Weight-of-Evidence Classification for human carcinogenicity of "B2", a "probable human carcinogen," based on sufficient animal evidence but inadequate human evidence (USEPA, 2004b). Even though the weight of evidence for lead carcinogenicity is B2, the USEPA does not evaluate lead cancer risk using a CSF, having concluded that neurological effects in young children are the most relevant endpoint.

5 Risk Characterization

In this section, cancer and non-cancer health risks are estimated by combining the information from Sections 2 through 4. The calculations used to estimate cancer and noncancer risks are presented in Sections 5.1 and 5.2, respectively. Section 5.3 discusses the calculated cancer and noncancer risks for each exposure area. Section 5.4 presents the lead risks by exposure area. Section 5.5 provides a qualitative discussion of the most significant sources of uncertainty in the risk estimates.

5.1 Calculation of Cancer Risks

Excess lifetime cancer risks are characterized as the incremental probability that an individual will develop cancer during his or her lifetime due to chemical exposure to constituents at the site under the specific exposure scenarios evaluated. The term "incremental" implies the risk above the background cancer risk experienced by all individuals in the course of daily life. According to Greenlee *et al.* (2001), the lifetime probability of developing cancer (*i.e.*, background cancer risk) is approximately 0.435 in men, and 0.383 in women. Cancer risks are expressed as a unitless probability (*e.g.*, one in a million, or 10^{-6}) of an individual developing cancer over a lifetime, above background risk, as a result of exposure to impacted environmental media at a site.

Excess (incremental) cancer risks for all of the exposure pathways (oral, dermal, and inhalation) are calculated using intake estimates (lifetime average daily doses, calculated in Section 3 as part of the exposure assessment) and CSFs (summarized as part of the toxicity assessment in Section 4) as follows (USEPA, 1989):

$$CancerRisk = Intake\left(\frac{mg}{kg \cdot day}\right) \times CSF\left(\frac{mg}{kg \cdot day}\right)^{-1}$$

For ingestion pathways, oral intake estimates (expressed as applied or administered dose levels) are multiplied by the oral CSF (applicable to applied/administered doses). Similarly, for inhalation pathways, inhalation intake estimates (also expressed as applied or administered dose levels) are multiplied by the inhalation CSF (applicable to applied/administered doses). For dermal exposures, dermal intake estimates (expressed as an absorbed dose level) are multiplied by an adjusted oral CSF (adjusted to apply to absorbed doses) (USEPA, 2004c). The total cancer risk for each receptor is the sum of the risks across all of the exposure pathways.

5.2 Calculation of Noncancer Risks

Risks from non-carcinogenic health effects are expressed as hazard quotients rather than as probabilities. A hazard quotient compares the calculated exposure (average daily doses, calculated as part of the exposure assessment in Section 3) to acceptable reference exposures derived by the USEPA (*e.g.,* RfDs, summarized as part of the toxicity assessment in Section 4). The hazard quotient is calculated from the RfD as follows (USEPA, 1989):

$$Hazard\,Quotient = \frac{Intake\left(\frac{mg}{kg \cdot day}\right)}{RfD\left(\frac{mg}{kg \cdot day}\right)}$$

For the ingestion exposure route an oral intake estimate (expressed as applied or administered dose) is divided by the oral RfD (applicable to applied/administered dose). Similarly, for the inhalation exposure route an inhalation intake estimate (also expressed as applied or administered dose) is divided by the inhalation RfD (applicable to applied/administered dose). For dermal exposure, a dermal intake estimate (expressed as an absorbed dose) is divided by an adjusted oral RfD (adjusted to apply to absorbed dose).

Hazard indices are calculated for each receptor and exposure pathway, according to USEPA guidance (1989). A hazard index greater than 1.0 is considered to represent a significant health risk. Because a hazard quotient is simply a ratio of site exposures to reference exposure levels (*e.g.*, RfDs, RfCs, *etc.*), hazard indices do not represent the probability that an adverse health effect could occur. They simply indicate whether an estimated exposure for an individual presents a significant noncancer health risk, based on the USEPA's recommended reference dose.

5.3 Estimated Cancer and Noncancer Risks

The estimated cancer and noncancer risks for arsenic are discussed below by exposure area. Lead risks are discussed separately in Section 5.4. Cancer risks are summarized in Table 5. The total cancer risk for each receptor is the sum of the risks over all exposure routes and all exposure periods. Noncancer risks are summarized in Table 5. The total noncancer risk for each receptor is the sum of the risks over all exposure routes. The detailed risk calculation tables in Appendix A present the arsenic risks calculated for each receptor and exposure pathway. The percent contribution of each exposure pathway to the total risk is also shown.

5.3.1 Main Facility Area

In the main facility area onsite, we evaluated a construction worker and a utility worker for exposure to arsenic in subsurface soil *via* incidental ingestion and dermal contact.

The total excess lifetime cancer risk is 7×10^{-6} for the construction worker, and 3×10^{-6} for the utility worker. These risk estimates are within USEPA's target risk range of 1×10^{-6} to 1×10^{-4}.

The total hazard index (HI) is 0.2 for the construction worker, and 0.05 for the utility worker. These values are well below a HI of 1.0.

5.3.2 Grassy Areas

In the grassy areas located north, south, and east of the main facility, we evaluated a future site worker, a groundskeeper, and an adolescent trespasser, for exposure to arsenic in surface soil *via* incidental ingestion and dermal contact.

The total excess lifetime cancer risks are 4×10^{-5} for the future site worker, 3×10^{-5} for the groundskeeper, and 2×10^{-6} for the adolescent trespasser. These risk estimates are within USEPA's target risk range of 1×10^{-6} to 1×10^{-4}.

The total hazard index (HI) is 0.3 for the future site worker, and 0.2 for the groundskeeper, and 0.06 for the adolescent trespasser. These values are well below a HI of 1.0.

5.3.3 Offsite Natural Gas Facility

At the off-site natural gas facility to the west of the RMC property, we evaluated a facility worker exposed to arsenic in surface soil *via* ingestion and dermal contact.

The total excess lifetime cancer risk is 8×10^{-6} for the gas facility worker. This risk estimate is within USEPA's target risk range of 1×10^{-6} to 1×10^{-4}.

The total hazard index (HI) is 0.05 for the gas facility worker. This value is well below a HI of 1.0.

Table 5
Summary of Cancer and Noncancer Risks

Exposure Area	Medium	Receptor	Total Excess Lifetime Cancer Risk	Total Hazard Index
Main Plant Area	Subsurface soil	Construction Worker	7E-06	0.2
		Utility Worker	3E-06	0.05
Grassy Areas	Surface soil	Groundskeeper	3E-05	0.2
		Adolescent Trespasser	2E-06	0.06
		Future Site Worker	4E-05	0.3
Off Site Natural Gas Facility	Surface soil	Adult Worker	8E-06	0.05

5.4 Lead Risk Assessment

5.4.1 Adult Lead Model

Blood lead levels (BLLs) in adolescents and adults are assessed using USEPA's Adult Lead Model (ALM) (USEPA, 1996). USEPA's Adult Blood Lead Model predicts a median BLL estimate for an adult as a function of the baseline BLL plus an increment that is attributable to exposure to site soil. This increment is a function of the biokinetic slope factor, the concentration of lead in soil, the soil ingestion rate, the fraction of lead in soil that is absorbed, and the exposure frequency. EPA has selected a target BLL for an adult female, in order to protect a developing fetus such that no more than 5% of fetuses would be expected to have BLLs exceeding 10 μg/dL.

The basic form of the equation for the ALM is as follows:

$$BLL_{adult} = PbB + \frac{(EF \times AF \times PbS \times IR \times BKSF)}{AT}$$

The input values used in the model are summarized in Table 6 and described below. First, an average baseline lead concentration in blood (PbB_{base}) for adults is identified to account for continuing exposure to background levels of lead in food, soil, and dust, and pre-existing body burdens due to prior lead exposures. Baseline BLLs were obtained from the most recent National Health and Nutrition Examination Survey, from 1999-2000 (NHANES, 2000) (U.S. Public Health Service, 2004). For adults we used the geometric mean (GM) and geometric standard deviation (GSD) BLLs for women of childbearing age (age 20-49). For the adolescent trespasser, we used the GM and GSD BLLs for males and females combined, for 13-18 year olds. To this baseline, the model adds the incremental increase in blood lead due to the lead source of interest (in this case, exposure to lead *via* ingestion of soil and dust).

The concentration of lead in soil (PbS) is the mean lead concentration in each exposure area. Lead uptake is calculated by multiplying the concentration of lead in soil by the soil/dust ingestion rate (IR) and the absorption fraction (AF) for lead in soil and dust. The AF is the amount of lead that is absorbed into the bloodstream from the gastrointestinal tract. The exposure frequency (EF) varies by receptor and exposure area. The EFs used for each receptor are presented in Table 3. The averaging time (AT) for chronic exposure to lead in soil is assumed to be one year (*i.e.*, 365 days). The biokinetic slope factor (BKSF) relates the incremental lead uptake into the body to an incremental increase in blood lead level in adults. USEPA's default value of 0.4 was used for the BKSF.

Table 6
Adult Lead Model Input Values

Term	Definition	Value
PbB_0	Geomean baseline BLL (μg/dL) for Adult females (age 20-49 yr)	1.2
GSD	Geometric standard deviation for Adult females	1.8
PbB_0	Geomean baseline BLL (μg/dL) for 13-18 yr old males and females	1.1
GSD	Geometric standard deviation for 13-18 yr old males and females	1.8
EF	Exposure Frequency (*i.e.*, number of days during the averaging time an individual is exposed to the lead source being evaluated (days))	Receptor-specific
AT	Averaging Time (days)	365
PbS	Soil/dust lead concentration (μg/g)	Area-Specific
IR	Soil/dust Ingestion Rate (g/day)	Receptor-specific 0.05 or 0.10
AF	Fraction of ingested lead absorbed into the blood stream (dimensionless)	0.12
BKSF	Biokinetic Slope Factor (change in blood lead per μg change in daily lead uptake) (μg/dL per μg/day)	0.4

Total BLLs for adults are predicted by adding the estimated incremental increase in blood lead to the average baseline BLL. A geometric standard deviation (GSD) appropriate for adults is used to estimate the probable range of BLLs around the predicted geometric mean adult BLL from the model. For this evaluation, we used the actual GSDs for the BLLs obtained from the NHANES-2000 database.

BLLs estimated using the ALM are evaluated based on a comparison to the USEPA risk management criterion for lead. Specifically, the health protection goal of the USEPA Office of Solid Waste and Emergency Response is to "limit exposure to soil lead levels such that a typical (or hypothetical) child or group of similarly exposed children would have an estimated risk of no more than 5% of exceeding a blood lead of 10 μg/dL" (USEPA, 1998). The Centers for Disease Control (CDC) recommend that "the goal of all lead poisoning prevention activities should be to reduce children's BLLs below 10 μg/dL" (CDC, 1991). Based on a goal of keeping the BLL in children at or below 10 μg/dL, the BLL for women of child-bearing age should not exceed 11.1 μg/dL, because the fetal BLL is approximately 90% of the maternal BLL (*i.e.*, 90% of 11.1 μg/dL is 10 μg/dL). A BLL goal of 10 μg/dL was used for the adolescent trespasser.

The adult lead modeling results for all receptors, along with the input values, the predicted BLLs, and the probability of exceeding the target BLL, are presented in Table 7. The adult lead modeling results are discussed below by exposure area. The dermal exposure route for lead in soil was not evaluated because this exposure route is typically insignificant when compared to ingestion. The ALM makes no provision for assessing dermal exposures.

Table 7
Summary of Lead Risks and Cleanup Goals

Exposure Variable	Description of Exposure Variable	Units	Construction Worker	Utility Worker	Grounds-keeper	Trespasser	Worker	Worker
		Soil Exposure Depth	0-5 ft	0-5 ft	0-6"	0-6"	0-6"	0-6"
			Values for Non-Residential Exposure Scenario					
			Onsite		Grassy Area			Offsite Gas Facility
PbS	Soil lead concentration	ug/g or ppm	**20,266**	20,266	**15,916**	15,916	**15,916**	1311
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9	0.9	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4	0.4	0.4	0.4	0.4
GSD_i	Geometric standard deviation PbB	--	1.8	1.8	1.8	1.8	1.8	1.8
PbB_0	Baseline PbB	ug/dL	1.2	1.2	1.2	1.1	1.2	1.2
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.100	0.100	0.050	0.050	0.050	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--	--	--	--	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--	--	--	--	--
K_{SD}	Mass fraction of soil in dust	--	--	--	--	--	--	--
$AF_{S,D}$	Absorption fraction (same for soil and dust)	--	0.12	0.12	0.12	0.12	0.12	0.12
$EF_{S,D}$	Exposure frequency (same for soil and dust)	days/yr	50	10	50	25	144	225
$AT_{S,D}$	Averaging time (same for soil and dust)	days/yr	365	365	365	365	365	365
PbB_{adult}	PbB of adult worker, geometric mean	ug/dL	15	3.9	6.4	3.7	16	3.1
$PbB_{fetal,0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	34	9.1	15	8.8	39	7.4
PbB_t	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	10.0	10.0	10.0	10.0	10.0	10.0
$P(PbB_{fetal} > PbB_t)$	Probability that fetal PbB > PbB_t, assuming lognormal distri	%	**68%**	4%	**18%**	3%	**74%**	2%
PRG	Preliminary Remediation Goal (PRG)	ppm	**4601**	23003	9201	19011	**3195**	2045
	Clean Fill (assumed)	ppm	50				50	
	Remedial Action Level (RAL)	ppm	**78,900**				**16,700**	

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

5.4.2 Main Facility Area

In the main facility area, lead risks were evaluated for a construction worker and a utility worker exposed to subsurface soil (0-5 ft). The predicted 95th percentile fetal BLLs are 34 μg/dL for the construction worker and 9.1 μg/dL for the utility worker. The predicted BLL for the fetus of the construction worker exceeds the BLL goal of 10 μg/dL, thus lead in subsurface soil poses an unacceptable risk in the main facility area. The exceedance is due to the elevated subsurface soil EPC of 20,266 mg/kg, which represents the average concentration for depths of 0-5 ft across the site. The utility worker has a much lower exposure frequency than the construction worker, thus his predicted 95th percentile BLL is below the adult 95th percentile goal of 10 μg/dL.

5.4.3 Grassy Areas

In the grassy area, lead risks were evaluated for a future site worker, a groundskeeper, and an adolescent trespasser exposed to surface soil. The predicted 95th percentile fetal BLLs are 15 μg/dL for the groundskeeper, 8.8 μg/dL for the trespasser, and 39 μg/dL for the future site worker. The predicted fetal BLLs for the groundskeeper and the future site worker exceed the BLL goal of 10 μg/dL, thus lead in surface soil poses an unacceptable risk in this exposure area. This exceedance is due to the elevated surface soil lead concentration in the grassy area (15,916 mg/kg).

5.4.4 Offsite Natural Gas Facility

At the offsite natural gas facility, lead risks were evaluated for an offsite worker exposed to surface soil. The predicted 95th percentile fetal BLL is 7.4 μg/dL for the offsite worker. The predicted BLL is below the goal of 10 μg/dL, therefore, lead does not pose a significant risk to a worker exposed to surface soil in this exposure area.

5.5 Uncertainty Analysis

The process of evaluating human health risks involves multiple steps. Inherent in each step of the process are uncertainties that ultimately affect the final risk estimates. Uncertainties may exist in numerous areas, including sample collection, laboratory analysis, derivation of toxicity values, and estimation of potential site exposures. These uncertainties may result in either an over- or under-estimation of risks. However, for this risk assessment, where uncertainties existed, Gradient took a conservative approach in regards to parameters, assumptions, and methodologies, so as to overestimate potential exposures and risks. The most important contributors to uncertainty in this risk assessment are discussed below.

5.5.1 Uncertainties in Exposure Assessment

Soil Ingestion Rate. The adult soil ingestion rate used in the risk calculations and in the ALM was the USEPA default value of 0.05 g/day. However, a survey of recent literature suggests that the average soil and dust ingestion rate value for adults is closer to 0.02 g/day (Bowers *et al.*, 1994).

Lead Absorption Fraction. A lead absorption fraction used in the ALM was USEPA's default value of 0.12. This value is based on 20% absorption of lead from water, and 60% relative bioavailability of lead from soil (0.20 x 0.60 = 0.12). The 20% absorption of lead from water is an upper-end value based on consumption on an empty stomach. This is a conservative assumption that may overestimate risk. O'Flaherty (1993) suggests that a value of 8% may be a more appropriate absorption value for food and water in adults. This value assumes that people consume food at average mealtimes throughout the day, therefore the lead absorption rate is slower due to the presence of food in the stomach. If we use an adult soil ingestion rate of 0.02 g/day, combined with a lead absorption fraction of 8% (or for soil, 0.08 x 0.6 = 0.048), we find that the lead risks calculated for adult receptors could be on the order of 60-70% lower than those presented here. Thus the adult lead risks presented in this report are likely conservative overestimates.

Fraction from site. Each receptor's daily soil exposure was assumed to be solely from impacted soil within the exposure area. This is a conservative assumption, since it is expected that workers would be at the site for only 8 hours a day, and would be exposed to soil and dust from other sources during the remaining part of each day (*e.g.*, from home). For instance, in the grassy area, the exposure is likely overestimated for the future site worker, since we assumed he would obtain 100% of this daily soil ingestion during the hour or so that he visits the grassy area at lunchtime.

Exposure Duration. Gradient assumed an upper bound (95th percentile) exposure duration of 25 years for the future site worker, groundskeeper, and offsite gas facility worker (USEPA, 1991). This assumption is conservative and is likely to result in an overestimate of exposure and risk for most workers, since many workers do not remain at the same job for 25 years.

5.5.2 Uncertainties in Arsenic Risk Assessment

Risk management decisions for arsenic are confounded by the unusual nature of natural arsenic background risks, which for both food and water yield cancer risks of 10^{-4} or higher, and because of the substantial uncertainty associated with the arsenic cancer slope factor. This section describes some of the unique uncertainties associated with arsenic. In general, the assumptions we have used tend to overestimate arsenic risks.

5.5.2.1 Background Levels of Arsenic in Food, Water, Air, and Soil

Humans are exposed to low levels of arsenic in food, water, air, and soil (ATSDR, 2000). Food is typically the largest source of arsenic exposure, with dietary exposure accounting for about 70% of the daily intake of inorganic arsenic (Borum and Abernathy, 1994). The U.S. EPA estimates that the U.S. population ingests approximately 18 μg of inorganic arsenic every day from food (USEPA 1988). This translates into a 4×10^{-4} cancer risk estimate based on continuous lifetime exposure, and EPA's current assessment of the carcinogenic potential of arsenic.

In the U.S., the average background level of arsenic in drinking water is approximately 2 μg/L (ATSDR, 2000). The recent U.S. EPA rule allows a permissible level or maximum contaminant level (MCL) of 10 μg/L arsenic in drinking water (USEPA, 2001a), a 5-fold lower value than the prior MCL of 50 μg/L. The rule allows community and non-transient, non-community water systems 5 years to attain compliance with the new MCL. Assuming the average background level and an ingestion rate of 2 L drinking water per day, an adult would ingest 4 μg inorganic arsenic per day. At the new MCL of 10 μg/L, an adult would ingest 20 μg inorganic arsenic per day, while at the old MCL of 50 μg/L, an adult would ingest 100 μg inorganic arsenic per day. These values translate into a range of cancer risk estimates between 9×10^{-5} and 2×10^{-3} based on continuous lifetime exposure, and EPA's current assessment of the carcinogenic potential of arsenic. EPA currently estimates that approximately 11 million people in the U.S. are served by community water systems with arsenic levels above the revised MCL. These people therefore have a cancer risk from water alone above 4×10^{-4}.

The mean levels of arsenic in ambient air range from less than 1 to 3 ng/m^3 in rural areas and from 20 to 30 ng/m^3 in urban areas (ATSDR, 2000). Assuming an inhalation rate of 20 m^3/day, an adult would breathe in less than 0.02 to 0.06 μg inorganic arsenic per day in rural areas, and 0.4 to 0.6 μg in urban areas. Arsenic levels could be higher in urban areas due to emissions from coal-fired power plants. However, the maximum concentrations measured in a 24-hour period are generally below 100 ng/m^3 (ATSDR, 2000). These background values translate into a range of cancer risk estimates between 4×10^{-7} and 1×10^{-5}.

Background arsenic levels in soil in Indiana range from 3.6 to 15 mg/kg, with an average concentration of 7.5 mg/kg (Dragun and Chiasson, 1991).

Total cancer risk from a combination of background exposures to arsenic in food, water, air, and soil may be as high as between 10^{-4} and 10^{-3} for a substantial portion of the U.S. population.

5.5.2.2 Body Burdens of Arsenic

Soil arsenic has a modest impact on body burden, as evidenced by urinary arsenic levels. Although elevated urinary arsenic levels were reported to be associated with very high soil arsenic levels near copper smelters (Baker *et al.*, 1977; Binder *et al.*, 1987), several studies consistently demonstrated that very low urinary arsenic levels were produced from soil arsenic concentrations below 200 mg/kg. In addition, the Anaconda, MT study demonstrated that urinary arsenic levels were unaffected by soil arsenic levels as high as 500 mg/kg. This observation occurs in part because of the small impact of soil arsenic relative to the impact of background levels of arsenic in food and water.

5.5.2.3 Bioavailability of Arsenic in Soil

Another explanation for the minor impact of soil arsenic on body burdens of arsenic is that arsenic in soil has a relatively low bioavailability and is absorbed into the body (*i.e.*, bloodstream) less efficiently than arsenic in water, the form used by U.S. EPA for the arsenic cancer slope factor. The bioavailability of arsenic in soil depends on two steps: solubilization in gastrointestinal (GI) fluids and absorption across the GI epithelium into the bloodstream (Valberg *et al.*, 1997). Both the solubilization and absorption depend on a variety of factors including the chemical forms of arsenic, the mode of intake by the individual (with or without food, type of food), and the nutritional status, which affects the pH throughout the GI tract, and GI transit time.

The solubility of arsenic depends on soil particle size and the associated soil matrix materials. Particle size affects solubility because larger particles dissolve more slowly than smaller particles, hence, the percentage dissolved during GI transit time increases as particle size decreases. Solubility of arsenic may be limited when insoluble matrix minerals (*e.g.,* quartz) encase arsenic compounds. Similarly, formation of iron-arsenic oxides and phosphates, and prevalence of authigenic carbonate and silicate complexes also limit the solubility of arsenic (Davis *et al.*, 1992, 1996). The solubility in the GI tract is complex since the pH conditions change from low pH in the stomach to a much higher pH in the small intestine. Readily soluble arsenic compounds, such as arsenate and arsenite, are more bioavailable than poorly soluble arsenic compounds, such as arsenic trioxide (ATSDR, 2000).

Several animal studies have evaluated the bioavailability of soil-bound arsenic. Results from Freeman *et al.* (1993 and 1995) and Groen *et al.* (1994) indicated that soil-bound arsenic is not as bioavailable as arsenic in solution. The bioavailability of soil arsenic relative to aqueous arsenic administered by gavage was approximately 20 percent in monkeys and 48 percent in rabbits. The higher relative bioavailability in rabbits reflected the higher absolute bioavailability in this species. This was much lower than the 64 to 69 percent of arsenic recovered in urine after ingestion of dissolved arsenic by human volunteers (Johnson and Farmer, 1991). Casteel *et al.* (1997) conducted a multi-year investigation of bioavailability of metals in soil and mine wastes using young swine whose GI system is more similar to humans than other animals. The relative bioavailability of arsenic in soils at various mining and smelting sites ranged from 7 to 52%, which agreed with the results of previous studies by Freeman *at al.* and Groen *et al.* Rodriguez *et al.* (1999) performed a similar swine study that reported the range of 2.7 to 42.8% relative bioavailability of arsenic in soil. Based on Gradient's literature review, a relative bioavailability of 50% is the maximum value reported in any of the peer-reviewed, published arsenic bioavailability studies. This evaluation used a relative bioavailability of 80%, based on guidance from USEPA Region 10. The relative bioavailability of 80% is thus likely to overestimate arsenic risks.

5.5.2.4 Cancer Slope Factor (CSF) for Arsenic

Reports on arsenic toxicity in humans are largely based on exposure to arsenic compounds in media other than soil, for example, consumption of drinking water and inhalation in occupational settings. USEPA has derived toxicity factors, *i.e.*, reference dose (RfD) and cancer slope factor (CSF), for ingested arsenic based on data from a Taiwanese study evaluating the health effects associated with the consumption of water containing high concentrations of arsenic (Chen *et al.*, 1985; Tseng *et al.*, 1968). Although the application of the population data used to derive the RfD and CSF has been heavily debated (Carlson-Lynch *et al.*, 1994; Smith *et al.*, 1995; Beck *et al.*, 1995; Mushak and Crocetti, 1995, 1996; Slayton *et al.*, 1996), the values derived are generally believed to be conservative.

The CSF is based on skin cancer observed in a study of over 40,000 people in Taiwan who were exposed for a significant portion of their lifetime to elevated levels of arsenic in groundwater. Although the study clearly indicates an association between high levels of arsenic exposure and cancer, the study design limits its usefulness to derive precise dose-response relationships. The reasons are summarized below:

Exposure Assessment. There are considerable scientific concerns about the exposure estimates in the Taiwanese study (USEPA Region 6, 1998). Individual exposures were not characterized, and exposures were based on average arsenic concentrations of ground water in wells in each village. The amount of exposure was broadly classified into three groups (high, medium and low) and the original data were not available. The analytical method used to measure arsenic concentrations may not be accurate at low levels.

Human-to-Human Variation. In general, dose levels, genetic factors, dietary patterns, or other life style factors may alter arsenic metabolism and detoxification in different populations (USEPA Region 6, 1998). Taiwanese may be more susceptible than U.S. population, and therefore CSF based on Taiwanese population may overestimate cancer for U.S. population. The protein deficiencies in Taiwanese diets could affect their ability to methylate and therefore detoxify arsenic, leading to an increase in cancer risk. Consequently, extrapolation from one population to another becomes highly uncertain.

Other Sources of Exposure. When the U.S. EPA derived the CSF, they did not take into account other possible sources of arsenic in the Taiwanese diet (*e.g.*, from rice and yams) and dietary uses of drinking water. Hence, the assumptions used by the U.S. EPA in deriving toxicity values for arsenic underestimate the total arsenic intake, and as a result, the CSF may overestimate cancer risks.

Non-Linear Dose-Response. A recent U.S. EPA panel concluded that the dose-response for arsenic appeared to be non-linear (USEPA, 1997b), and the U.S. EPA Region 6 concluded that the available data "support a plausible threshold" (USEPA Region 6, 1998). The possible sub-linear or threshold dose-response relationship suggests that cancer risk at low doses of arsenic may be less than predicted based on a linear model.

Arsenic Differs in Water and Soil. Health effects associated with arsenic in water may not be relevant to assess the toxicity in soil (Valberg *et al.*, 1997). Arsenic exists in different chemical forms in water and soil, which may lead to potential differences in systemic bioavailability and dose-to-target organ. The relative proportion of overall arsenic intake and the correlation with urinary-arsenic concentrations may also be different between arsenic in water and soil. The differences will ultimately impact the overall potential for adverse health effects.

Overall, these uncertainties limit precise quantification of the dose-response relationship, but suggest the current CSF may overestimate cancer risks for a U.S. population exposed to lower levels of arsenic. Two recently published articles provide evidence that the CSF overestimates the cancer risk for arsenic as applied to drinking water studies outside the U.S. (Guo and Valberg, 1997) and within the U.S. (Valberg *et al.*, 1998). These papers report a meta-analysis of epidemiological studies evaluating the skin cancer incidence of 29 populations in India, Japan, Mexico, Taiwan and the U.S. who were exposed to 1.17 to 270 μg/L arsenic in water. The authors evaluated the validity of U.S. EPA arsenic CSF model to predict the expected number of skin cancers by conducting a likelihood ratio analysis. This analysis showed that a null hypothesis of no additional skin cancer risk from arsenic was approximately two times more likely than the hypothesis of the predicted rate of skin cancer from arsenic. This analysis indicated that the CSF derived from arsenic exposure in the Taiwanese populations is likely to be an overestimate when applied to the U.S. populations.

Additionally, in the epidemiological studies of a U.S. population that has been exposed to arsenic in drinking water, no increased cancer rate has been observed (USEPA Region 6, 1998). This is further supported by studies of individuals exposed to arsenic in soil who thus far have not indicated any toxicity (Binder *et al.*, 1987; Wong *et al.*, 1992).

5.5.2.5 Summary of Arsenic Risks and Uncertainty

Any effect of arsenic in soil on total arsenic body burden is difficult to observe as a result of the commonly reduced bioavailability of arsenic in soil, and the extent to which soil's contribution to body burden is overwhelmed by background levels of arsenic in food and water. Coupling these considerations with the uncertainty in the derivation of the arsenic cancer slope factor suggest that an acceptable risk level for soil arsenic may be close to 10^{-4}.

5.5.3 Uncertainties in Risk Characterization

Uncertainties associated with the first three steps of the risk assessment (data collection, exposure assessment, and toxicity assessment) are incorporated into the risk estimates in the risk characterization step. Although there are numerous uncertainties associated with this risk assessment, the incorporation of a large number of conservative assumptions has yielded risk estimates that are likely to overestimate actual site risks.

6 Soil Lead Cleanup Levels and Residual Risk

6.1 Soil Cleanup Levels

Lead risks are unacceptable for the construction worker in the main facility area, and the groundskeeper and the future site worker in the grassy area. Therefore, soil lead cleanup levels were calculated for these areas.

A preliminary remediation goal (PRG) is the average concentration in an exposure area that will result in an acceptable risk to a particular receptor. PRGs are risk-based target cleanup levels that must be met *on average* throughout the exposure area. It is acceptable to leave concentrations that exceed the cleanup level, so long as the post-remediation *average* concentration does not exceed the risk-based cleanup level.

The Remedial Action Level (RAL) is the concentration above which soil must be removed, so that the post-remediation *average* concentration meets the specified target cleanup level (USEPA, 2001b). The RAL is a remedial action goal (*i.e.*, a remediation trigger concentration) that ensures the post-remediation average concentration at a site achieves the target cleanup level with a specified level of confidence.

PRGs for lead were calculated for subsurface soil (0-5 feet) in the main facility area and surface soil (0-6 inches) in the grassy area (Table 7). In the main facility area, the PRG for lead in subsurface soil is 4600 mg/kg for the construction worker. In the grassy area, the PRG for surface soil is 3195 mg/kg for the future site worker.

RALs were calculated for these two receptors, assuming that excavated soil would be replaced with clean backfill containing lead at 50 mg/kg. The RAL for the main facility area is 78,900 mg/kg for subsurface soil. The RAL for surface soil in the grassy area is 16,700 mg/kg.

6.2 Post-Remediation Residual Risk

The residual risk from arsenic was calculated assuming that soil was remediated to the lead RAL in the main facility area and the grassy area. The post-remediation arsenic EPCs for these two exposure areas were calculated (using ProUCL) assuming that excavated soil was replaced with clean backfill containing arsenic at 5 mg/kg. The post-remediation arsenic EPCs are 41.2 mg/kg in the main facility area, and 40.7 mg/kg in the grassy area (Table 8). Both of these EPCs were the nonparametric UCL calculated with the "bootstrap-t" method. Residual cancer risks range from 3×10^{-7} to 8×10^{-6} (Table 8). Residual noncancer risks range from 0.01 to 0.1 (Table 8).

Table 8
Summary of Post-Remediation Risks for Arsenic

			Baseline	Post Remediation	Post Remediation	Post Remediation
Exposure Area	**Medium**	**Receptor**	**Arsenic EPC (mg/kg)**	**Arsenic EPC (mg/kg)**	**Total Excess Lifetime Cancer Risk**	**Total Hazard Index**
Main Plant Area	Subsurface soil	Construction Worker	123	41.2	2E-06	0.1
		Utility Worker	123	41.2	1E-06	0.02
Grassy Areas	Surface soil	Future Site Worker	312	40.7	6E-06	0.04
		Groundskeeper	312	40.7	4E-06	0.03
		Adolescent Trespasser	312	40.7	3E-07	0.01
Off Site Natural Gas Facility	Surface soil	Adult Worker	28.5	28.5	8E-06	0.05

7 Conclusions

Cancer risks attributable to arsenic were calculated for receptors in three exposure areas. All of the calculated cancer risks fall within USEPA's target risk range of 1×10^{-6} to 1×10^{-4}. The exposure scenario with the highest excess lifetime cancer risk is the future site worker in the grassy area (4×10^{-5}). The exposure pathway with the greatest contribution to cancer risk is soil ingestion.

Noncancer risks attributable to arsenic were calculated for receptors in three exposure areas. All of the calculated noncancer risks are below USEPA's target hazard index of 1.0. The exposure scenario with the highest noncancer risk is the onsite construction worker (HI of 0.4). The exposure pathway with the greatest contribution to noncancer risk for the resident is soil ingestion.

Lead risks were evaluated for adult and/or adolescent receptors in three exposure areas. Lead risks were evaluated by comparing the predicted fetal BLL for each receptor to USEPA's BLL goal of 10 µg/dL. Predicted 95th percentile fetal BLLs exceeded USEPA goals for the construction worker exposed to subsurface soil in the main facility area, and the groundskeeper and future site worker exposed to surface soil in the grassy area. The predicted 95th percentile fetal BLL did not exceed the USEPA goal for the offsite gas facility worker.

The residual risk from arsenic was calculated assuming that soil was remediated to the lead RAL in the main facility area and the grassy area. Residual cancer risks range from 3×10^{-7} to 8×10^{-6}, and residual noncancer risks range from 0.01 to 0.1.

8 References

Abernathy, C.O., W. Marcus, C. Chen, *et al.* 1989. Internal Memorandum to P. Cook/P. Preuss re: Report on Arsenic (As) Work Group Meetings. US EPA, Office of Drinking Water, Washington, DC.

Advanced GeoServices Corp. (AGC). 2000. Advanced GeoServices Corp. RCRA Facility Investigation Report. Prepared for Refined Metals Corp. (Beech Grove, IN). August 31.

Advanced GeoServices Corp. (AGC). 2002. Phase II RCRA Facility Investigation Report. Prepared for Refined Metals Corp. (Beech Grove, IN). November 18.

Agency for Toxic Substances and Disease Registry (ATSDR). 1999. "Toxicological Profile for Lead (Update)." Report to US Public Health Service, Agency for Toxic Substances and Disease Registry (ATSDR) National Technical Information Service (NTIS), Springfield, VA. NTIS PB99-166704. July.

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. "Toxicological Profile for Arsenic (Update.)" National Technical Information Service, Springfield, VA. Prepared for US Public Health Service, Agency for Toxic Substances and Disease Registry (ATSDR). NTIS PB2000-108021. 446p. September.

Baker, E., C. Hayes, P. Landrigan, J. Handke, R. Leger, W. Houseworth and J. Harrington. 1977. A nationwide survey of heavy metal absorption in children living near primary copper, lead, and zinc smelters. *Am. J. Epidemiol.* 106(4):261-273.

Beck, B.D., P.D. Boardman, G.C. Hook, R.A. Rudel, T.M. Slayton and H. Carlson-Lynch. 1995. Correspondence: Response to Smith *et al. Environ. Health Perspect.* 103(1):15-16.

Binder, S., D. Forney, W. Kaye and D. Paschal. 1987. Arsenic exposure in children living near a former copper smelter. *Bull. Environ. Contam. Toxicol.* 39:114-121.

Borum, D.R. and C.O. Abernathy. 1994. Human oral exposure to inorganic arsenic. In *Arsenic, Exposure and Health* (W.R. Chappell, C.O. Abernathy and C.R. Cothern, Eds.), p. 21-29. Science and Technology Letters, Northwood, England.

Bowers, T.S., Beck, B.D., Karam, H.S. 1994. Assessing the relationship between environmental lead concentrations and adult blood lead levels. *Risk Analysis, Volume 14, No.2.*

Carlson-Lynch, H., B.D. Beck and P.D. Boardman. 1994. Arsenic risk assessment: A commentary. *Environ. Health Perspect.* 102(4):354-356.

Casteel, S.W., L.D. Brown, M.E. Dunsmore, C.P. Weis, G.M. Henningsen, E. Hoffman, W.J. Brattin, and T.L. Hammon. 1997. Relative bioavailability of arsenic in mining wastes. Report to EPA, Region 8.

Centers for Disease Control (CDC). 1991. "Draft CDC Lead Statement: Preventing Lead Poisoning in Young Children." March.

Chappell, W.R., B.D. Beck, K.G. Brown, R. Chaney, C.R. Cothern, K.J. Irgolic, D.W. North, I. Thornton, and T.A. Tsongas. 1997. Inorganic arsenic: A need and an opportunity to improve risk assessment. *Environmental Health Perspectives* 105(10):1060-1067.

Chen, C.-J., Y.-C. Chuang, T.-M. Lin and H.-Y. Wu. 1985. Malignant neoplasms among residents of a blackfoot disease-endemic area in Taiwan: High arsenic artesian well water and cancers. *Cancer Res.* 45:5895-5899.

Davis, A., M.V. Ruby and P.D. Bergstrom. 1992. Bioavailability of arsenic and lead in soils from the Butte, Montana, mining district. *Environmental Science and Technology* 26(3):461-468.

Davis, A., M.V. Ruby, M. Bloom, R. Schoof, G. Freeman and P.D. Bergstrom. 1996. Mineralogic constraints on the bioavailability of arsenic in smelter-impacted soils. *Environmental Science and Technology* 30(2):392-399.

Dragun, J. and A. Chiasson. 1991. *Elements in North American Soils.* Hazardous Materials Control Resources Institute, Maryland, 238p.

Freeman, G.B., J.D. Johnson, J.M. Killinger, S.C. Liao, A.O. Davis, M.V. Ruby, R.L. Chaney, S.C. Lovre and P.D. Bergstrom. 1993. Bioavailability of arsenic in soil impacted by smelter activities following oral administration in rabbits. *Fundamental Applied Toxicology* 21:83-88.

Freeman, G., R. Schoof, M. Ruby, A. Davis, J. Dill, S. Liao, C. Lapin and P. Bergstrom. 1995. Bioavailability of arsenic in soil and house dust impacted by smelter activities following oral administration in cynomolgus monkeys. *Fundamental Applied Toxicology* 28:215-222.

Greenlee, R.T., M.B. Hill-Harmon, T. Murray, and M. Thun. 2001. Cancer statistics, 2001. *CA Cancer J. Clin.* 51:15-36.

Groen, K, H.A.M.G. Vaessen, J.J.G. Kliest, J.L.M. deBoer, T. van Ooik, A. Timmerman and R.F. Vlug. 1994. Bioavailability of arsenic from bog ore-containing soil in the dog. *Environmental Health Perspective* 102(2):182-184.

Guo, H.R. and P.A. Valberg. 1997. Evaluation of the validity of the US EPA's cancer risk assessment of arsenic for low-level exposures: A likelihood ratio approach. *Environ. Geochem. Health* 19:133-141.

Johnson, L.R. and J.G. Farmer. 1991. Use of human metabolic studies and urinary arsenic speciation in assessing arsenic exposure. *Bull. Environ. Contam. Toxicol.* 46:53-61.

Mushak, P. and A.F. Crocetti. 1995. Commentary: Risk and revisionism in arsenic cancer risk assessment. *Environ. Health Perspect.* 103(7-8):684-689.

Mushak, P. and A.F. Crocetti. 1996. Correspondence-Response: Accuracy, arsenic, and cancer. *Environ. Health Perspect.* 104(10):1014-1018.

O'Flaherty, E.J. 1993. Physiologically based models for bone-seeking elements. IV. Kinetics of lead disposition in humans. *Toxicol. Appl. Pharmacol.* 118 :16-29.

Rodriguez, R.R., N.T. Basta, S.W. Casteel and L.W. Pace. 1999. An *in vitro* gastrointestinal method to estimate bioavailable arsenic in contaminated soils and solid media. *Environmental Science and Technology* 33(4):642-649.

Slayton, T.M., B.D. Beck, K.A. Reynolds, S.D. Chapnick, P.A. Valberg, L.J. Yost, R.A. Schoof, T.D. Gauthier, and L. Jones. 1996. Correspondence: issues in arsenic cancer risk assessment. *Environ. Health Perspect.* 104(10):1012–1014.

Smith, A.H., M.-L. Biggs, C. Hopenhayn-Rich and D. Kalman. 1995. Correspondence: Arsenic risk assessment. *Environ. Health Perspect.* 103(1):13-15.

Tseng, W.P., H.M. Chu, and S.W. How. 1968. Prevalence of skin cancer in an endemic area of chronic arsenicism in Taiwan. *J. Nat. Cancer Inst.* 3:453(10).

Tseng, W.P. 1977. Effects and dose response relationships of skin cancer and blackfoot disease with arsenic. *Environ. Health Perspectives* 19:109-119.

U.S. Environmental Protection Agency (USEPA). 1988. "Special Report on Ingested Inorganic Arsenic - Skin Cancer: Nutritional Essentiality." EPA/625/3-87/013. July.

U.S. Environmental Protection Agency (USEPA). 1989. "Risk Assessment Guidance for Superfund (RAGS), Vol. I, Human Health Evaluation Manual (Part A)." Office of Emergency and Remedial Response, Washington, D.C. OSWER Directive 9285.7-01A. EPA-540/1-89-002. December.

U.S. Environmental Protection Agency (USEPA). 1991. "Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual. Supplemental Guidance: Standard Default Exposure Factors. Interim Final." Office of Emergency and Remedial Response, Toxics Integrations Branch, Washington, DC. OSWER Directive: 9285.6-03. March 25.

U.S. Environmental Protection Agency (USEPA). 1992a. "Dermal Exposure Assessment: Principals and Applications, Interim Report." Exposure Assessment Group, Office of Health and Environmental Assessment, Washington, D.C. EPA/600/8-91/011B.

U.S. Environmental Protection Agency (USEPA). 1992b. "Supplemental Guidance to RAGS: Calculating the Concentration Term." Office of Solid Waste and Emergency Response, Washington, D.C. PB92-963373. May.

U.S. Environmental Protection Agency (USEPA). 1992c. "Integrated Risk Information System (IRIS): EPA's Approach for Assessing the Risks Associated with Chronic Exposures to Carcinogens. Background Document 2." www.epa.gov/ngispgm3/iris/carcino.htm. January 17. Retrieved January 11, 2001.

U.S. Environmental Protection Agency (USEPA). 1993. "Integrated Risk Information System (IRIS): Reference Dose (RfD): Description and Use in Health Risk Assessments. Background Document 1A." www.epa.gov/ ngispgm3/iris/rfd.htm. March 15. Retrieved January 11, 2001.

U.S. Environmental Protection Agency (USEPA). 1994. "Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children." US EPA, Technical Review Workgroup for Lead. Prepared for UP EPA, Office of Emergency and Remedial Response (Research Triangle Park, NC) OERR Publication 9285.7-15-1; EPA540-R-93-081; NTIS PB93-963510. February.

U.S. Environmental Protection Agency (USEPA). 1996. "Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil." Technical Review Workgroup for Lead. December.

U.S. Environmental Protection Agency (USEPA). 1997a. "Exposure Factors Handbook. Volumes I, II, III." Office of Research and Development, Washington, D.C. EPA/600/P-95/002Fa-c. August.

U.S. Environmental Protection Agency (USEPA). 1997b. "Report on the Expert Panel on Arsenic Carcinogenicity: Review and Workshop." National Center for Environmental Assessment, Washington, DC. August.

U.S. Environmental Protection Agency (USEPA). 1998. "Clarification to the 1994 Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities." Office of Solid Waste and Emergency Response. OSWER Directive #9200.4-27, EPA/540/F-98-030. August.

U.S. Environmental Protection Agency (USEPA). 2001a. "Drinking Water Standards for Arsenic." Office of Water. EPA 815-F-00-015. January.

U.S. Environmental Protection Agency (USEPA). 2001b. "Risk Assessment Guidance for Superfund (RAGS). Volume III: Part A, Process for Conducting Probabilistic Risk Assessment." Office of Emergency and Remedial Response, Washington, DC. EPA 540-R-02-002; Publication 9285.7-45; PB2002-963302. 385p. December. http://www.epa.gov/superfund/programs/risk/rags3adt/pdf/chapters.pdf.

U.S. Environmental Protection Agency (USEPA). 2002a. "Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites [Supplemental Guidance to RAGS.]" Office of Emergency and Remedial Response (Washington, DC). OSWER Directive 9285.6-10. 32p. December. http://www.epa.gov/superfund/programs/risk/ragsa/ucl.pdf.

U.S. Environmental Protection Agency (USEPA). 2002b. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Emergency and Remedial Response. OSWER 9355.4-24. December.

U.S. Environmental Protection Agency (USEPA). 2003. "Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil." Technical Review Workgroup for Lead. Report to US EPA, Office of Solid Waste and Emergency Response/Office of Emergency and Remedial Response, Washington, DC. EPA-540-R-03-001; OSWER Directive 9285.7-54. January. http://www.epa.gov/superfund/programs/lead/products/adultpb.pdf.

U.S. Environmental Protection Agency (USEPA). 2004a. Integrated Risk Information System (IRIS). Arsenic, Inorganic. http://www.epa.gov/iris/subst/0278.htm

U.S. Environmental Protection Agency (USEPA). 2004b. Integrated Risk Information System (IRIS). Lead and Compounds (Inorganic). http://www.epa.gov/IRIS/subst/0277.htm.

U.S. Environmental Protection Agency (USEPA). 2004c. "Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual. Part E. Supplemental Guidance for Dermal Risk Assessment. Final." Office of Emergency and Remedial Response, Washington, DC. EPA/540/R/99/005. OSWER 9285.7-02EP. PB99-963312. July.

U.S. Environmental Protection Agency Region 6 (USEPA Region 6). 1998. "Region 6 Interim Strategy: Arsenic – Freshwater Human Health Criterion for Fish Consumption, Appendix B: Health Effects of Arsenic." http://www.epa.gov/earth1r6/6wq/ecopro/watershd/standard/arsenic.htm. Retrieved May 6, 1998; last updated February 4, 1998.

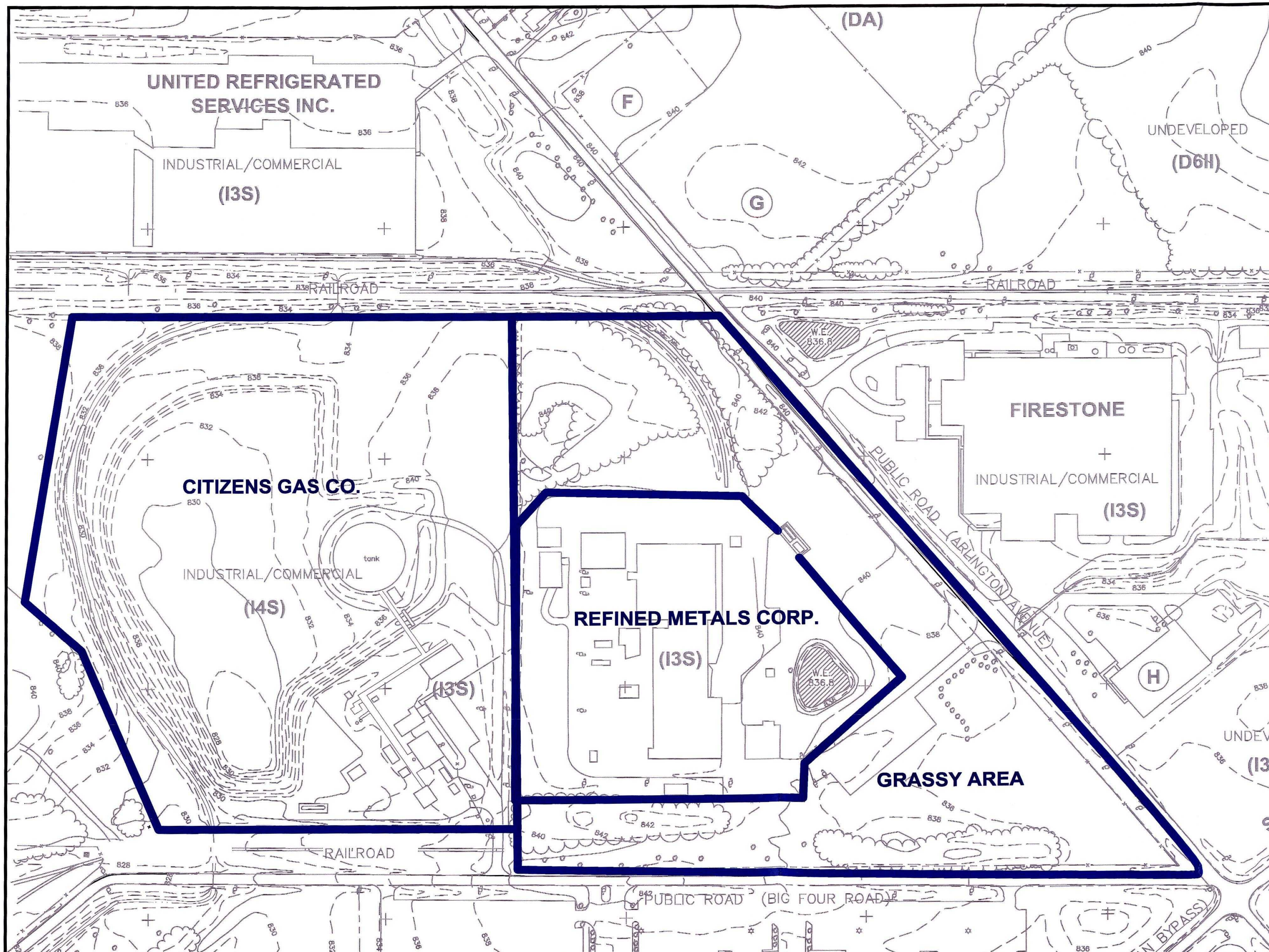
U.S. Environmental Protection Agency Region 10 (USEPA Region 10). 1997. "Supplemental Ecological Risk Assessment Guidance for Superfund." Office of Environmental Assessment, Risk Evaluation Unit. EPA 910-R-97-005. June.

U.S. Public Health Service. 2004. "National Health and Nutrition Examination Survey, 1999-2000. (NHANES, 2000). National Center for Health Statistics. Downloaded from: http://www.cdc.gov/nchs/about/major/nhanes/NHANES99_00.htm - Laboratory%20Files.

Valberg, P.A., B.D. Beck, T.S. Bowers, J.L. Keating, P.D. Bergstrom, and P.D. Boardman. 1997. Issues in setting health-based cleanup levels for arsenic in soil. *Regul Toxicol Pharmacol* 26:219-229.

Valberg, P.A., B.D. Beck, P.D. Boardman, and J.T. Cohen. 1998. Likelihood ratio analysis of skin cancer prevalence associated with arsenic in drinking water in the USA. *Environ. Geochem. Health* 20:61-66.

Wong, O., M.D. Whorton, D.E. Foliart, R. Lowengart. 1992. An ecologic study of skin cancer and environmental arsenic exposure. *Int. Arch. Occup. Environ. Health* 64:235-241.



Gradient CORPORATION
20 UNIVERSITY ROAD • CAMBRIDGE, MA 02138 • (617) 395-5000

FIGURE 1

EXPOSURE AREAS

EXIDE – BEECH GROVE, INDIANA

DRAWN BY: (PSG)	REVISED BY: JJC	PROJ. NO.: 203030
DATE: --	DATE: 06/21/04	FILE: RA_Boundaries

Appendix A

Risk Calculation Tables

Appendix A
Arsenic Risk Summary

Receptor/Exposure Pathway		Cancer Risk	Hazard Index
Onsite Construction Worker			
Dermal Contact with Soil		5.11E-07	0.0159
Ingestion of Soil		6.82E-06	0.212
	Total:	**7E-06**	**0.2**
Onsite Utility Worker			
Dermal Contact with Soil		2.05E-07	0.0032
Ingestion of Soil		2.73E-06	0.042
	Total:	**3E-06**	**0.05**
Grassy Area Site Worker			
Dermal Contact with Soil		6.52E-06	0.041
Ingestion of Soil		3.77E-05	0.23
	Total:	**4E-05**	**0.3**
Grassy Area Groundskeeper			
Dermal Contact with Soil		6.47E-06	0.040
Ingestion of Soil		2.62E-05	0.16
	Total:	**3E-05**	**0.2**
Grassy Area Adolescent Trespasser			
Dermal Contact with Soil		3.54E-07	0.011
Ingestion of Soil		1.58E-06	0.049
	Total:	**2E-06**	**0.1**
Offsite Gas Facility Worker			
Dermal Contact with Soil		2.66E-06	0.017
Ingestion of Soil		5.38E-06	0.033
	Total:	**8E-06**	**0.1**

Appendix A
Excess Lifetime Cancer Risk by Chemical and Pathway for All Receptors

Ingestion of Soil

Receptor	Chemicals Evaluated	Intake Factor (IF)	Soil Concentration (C) (mg/kg)	Bioavailability (R)	Daily Intake DI = C×IF×R (mg/kg·d)	Slope Factor (SF) (kg·d/mg)	Cancer Risk CR = DI×SF
Onsite Construction Worker	Arsenic	4.61E-08	123	8.00E-01	4.55E-06	1.5	6.82E-06
Onsite Utility Worker	Arsenic	1.85E-08	123	8.00E-01	1.82E-06	1.5	2.73E-06
Grassy Area Site Worker	Arsenic	1.01E-07	312	8.00E-01	2.51E-05	1.5	3.77E-05
Grassy Area Landscaper	Arsenic	6.99E-08	312	8.00E-01	1.74E-05	1.5	2.62E-05
Grassy Area Adolescent Trespasser	Arsenic	4.22E-09	312	8.00E-01	1.05E-06	1.5	1.58E-06
Offsite Gas Facility Worker	Arsenic	1.57E-07	28.5	8.00E-01	3.59E-06	1.5	5.38E-06

Notes:

Daily Intake (DI) = Concentration (C) * Intake Factor (IF) * Bioavailability (R)

where:

IF = Intake Factor (IR * FS * EF * ED * CF) / (BW * AT)
AT = Averaging Time - Noncancer (d)
AT = Averaging Time - Cancer (d)
BW = Body Weight (kg)
CF = Conversion Factor (kg/mg)
ED = Soil Ingestion Exposure Duration (yr)
EF = Soil Ingestion Exposure Frequency (d/yr)
FS = Fraction Soil from Contaminated Source
IR = Soil Ingestion Rate (mg/d)

Appendix A
Excess Lifetime Cancer Risk by Chemical and Pathway for All Receptors

Dermal Contact with Soil

Receptor	Chemicals Evaluated	Intake Factor (IF)	Soil Concentration (C) (mg/kg)	Dermal Absorption (A)	Daily Intake DI=C×IF×A (mg/kg·d)	Slope Factor (SF) (kg·d/mg)	Cancer Risk CR=DI×SF
Onsite Construction Worker	Arsenic	9.23E-08	123	3.00E-02	3.41E-07	1.5	5.11E-07
Onsite Utility Worker	Arsenic	3.69E-08	123	3.00E-02	1.36E-07	1.5	2.05E-07
Grassy Area Site Worker	Arsenic	4.65E-07	312	3.00E-02	4.35E-06	1.5	6.52E-06
Grassy Area Landscaper	Arsenic	4.61E-07	312	3.00E-02	4.31E-06	1.5	6.47E-06
Grassy Area Adolescent Trespasser	Arsenic	2.52E-08	312	3.00E-02	2.36E-07	1.5	3.54E-07
Offsite Gas Facility Worker	Arsenic	2.08E-06	28.5	3.00E-02	1.77E-06	1.5	2.66E-06

Notes:

Daily Intake (DI) = Concentration (C) * Intake Factor (IF) * Dermal Absorption (A)

where:

IF = Intake Factor (AF * SA * EF * ED * CF) / (BW * AT)
AT = Averaging Time - Noncancer (d)
AT = Averaging Time - Cancer (d)
BW = Body Weight (kg)
CF = Conversion Factor (kg/mg)
ED = Soil Dermal Exposure Duration (yr)
EF = Soil Dermal Exposure Frequency (events/yr)
SA = Surface Area Exposed to Soil (cm^2/event)
AF = Soil Soil/Skin Adherence Factor (mg/cm^2)

Appendix A
Noncancer Hazard Quotient by Chemical and Pathway for All Receptors

Ingestion of Soil

Receptor	Chemicals Evaluated	Intake Factor (IF)	Soil Concentration (C) (mg/kg)	Bioavailability (R)	Daily Intake DI = C×IF×R (mg/kg·d)	Reference Dose (RfD) (mg/kg·d)	Hazard Quotient HQ=DI÷RfD
Onsite Construction Worker	Arsenic	6.46E-07	123	8.00E-01	6.36E-05	3.00E-04	2.12E-01
Onsite Utility Worker	Arsenic	1.29E-07	123	8.00E-01	1.27E-05	3.00E-04	4.24E-02
Grassy Area Site Worker	Arsenic	2.82E-07	312	8.00E-01	7.03E-05	3.00E-04	2.34E-01
Grassy Area Landscaper	Arsenic	1.96E-07	312	8.00E-01	4.88E-05	3.00E-04	1.63E-01
Grassy Area Adolescent Trespasser	Arsenic	5.90E-08	312	8.00E-01	1.47E-05	3.00E-04	4.91E-02
Offsite Gas Facility Worker	Arsenic	4.40E-07	28.5	8.00E-01	1.00E-05	3.00E-04	3.35E-02

Notes:

Daily Intake (DI) = Concentration (C) * Intake Factor (IF) * Bioavailability (R)

where:

IF = Intake Factor (IR * FS * EF * ED * CF) / (BW * AT)
AT = Averaging Time - Noncancer (d)
AT = Averaging Time - Cancer (d)
BW = Body Weight (kg)
CF = Conversion Factor (kg/mg)
ED = Soil Ingestion Exposure Duration (yr)
EF = Soil Ingestion Exposure Frequency (d/yr)
FS = Fraction Soil from Contaminated Source
IR = Soil Ingestion Rate (mg/d)

Appendix A
Noncancer Hazard Quotient by Chemical and Pathway for All Receptors

Dermal Contact with Soil

Receptor	Chemicals Evaluated	Intake Factor (IF)	Soil Concentration (C) (mg/kg)	Dermal Absorption (A)	Daily Intake DI=C×IF×A (mg/kg·d)	Reference Dose (RfD) (mg/kg·d)	Hazard Quotient HQ=DI÷RfD
Onsite Construction Worker	Arsenic	1.29E-06	123	3.00E-02	4.77E-06	3.00E-04	1.59E-02
Onsite Utility Worker	Arsenic	2.58E-07	123	3.00E-02	9.54E-07	3.00E-04	3.18E-03
Grassy Area Site Worker	Arsenic	1.30E-06	312	3.00E-02	1.22E-05	3.00E-04	4.05E-02
Grassy Area Landscaper	Arsenic	1.29E-06	312	3.00E-02	1.21E-05	3.00E-04	4.02E-02
Grassy Area Adolescent Trespasser	Arsenic	3.53E-07	312	3.00E-02	3.30E-06	3.00E-04	1.10E-02
Offsite Gas Facility Worker	Arsenic	5.81E-06	28.5	3.00E-02	4.97E-06	3.00E-04	1.66E-02

Notes:

Daily Intake (DI) = Concentration (C) * Intake Factor (IF) * Dermal Absorption (A)

where:

IF = Intake Factor (AF * SA * EF * ED * CF) / (BW * AT)
AT = Averaging Time - Noncancer (d)
AT = Averaging Time - Cancer (d)
BW = Body Weight (kg)
CF = Conversion Factor (kg/mg)
ED = Soil Dermal Exposure Duration (yr)
EF = Soil Dermal Exposure Frequency (events/yr)
SA = Surface Area Exposed to Soil (cm^2/event)
AF = Soil Soil/Skin Adherence Factor (mg/cm^2)

CORRECTIVE MEASURES STUDY REPORT
PHASE I

Prepared For:

REFINED METALS CORPORATION

Prepared By:

ADVANCED GEOSERVICES CORP.
West Chester, Pennsylvania

Project No. 2003-1046-02
June 22, 2004

F:\OFICEAGC\PROJECTS\Files\2003-1046\Reports\Corrective Measures\Phase I text.doc

DRAFT

TABLE OF CONTENTS

ATTACHMENTS

1.0 INTRODUCTION

Presented herein, is the Phase I Corrective Measures Study (CMS) Report for the Refined Metals Corporation (RMC) facility in Beech Grove Indiana. Pursuant to the CMS Work Plan, approved by USEPA in a letter dated November 5, 2003, this report has been prepared to present the results of the additional sampling activities and the preliminary risk assessment results. A description of the activities is provided in the following sections. Copies of the completed documents are provided as attachments.

2.0 FIELD ACTIVITIES

Based on an evaluation of previous investigation results following the Phase II RCRA Facility Investigation (RFI), a determination was made that additional characterization sampling was required for sediment and groundwater at the RMC Site. The sediment sampling consisted of collecting additional samples from the drainage ditch along the CSX Transportation railroad right-of-way north of the facility and from the grass lined drainage ditch along the west side of Arlington Avenue. Sediment samples were collected from 6 locations along the railroad drainage ditch and 4 locations in the Arlington Avenue drainage ditch. Two samples were collected at each location. Along Arlington Avenue, one sample was collected from the 0 to 6-inch depth and the second from the 6 to 12-inch depth. Along the railroad right-of-way, they were collected from 0 to 3 inches and 3 to 10 inches.

Groundwater sampling included the installation of three piezometers in the area north and east of the former manufacturing area. The piezometers were installed with the intent of further refining groundwater flow direction prior to selection of locations for the new monitoring wells. The piezometers were allowed to set for 24 hours before groundwater level measurements were taken from the existing shallow monitoring wells at the north end of the former manufacturing area and the piezometers. Groundwater flow direction was re-assessed based on the measurements and the locations for two new groundwater-monitoring wells were selected. The new groundwater monitoring wells were installed using hollow stem auger (HSA) drilling techniques. The piezometers were abandoned after groundwater level measurements were taken. Groundwater samples were collected from all the Site groundwater monitoring wells between October 26 and 28, 2004 using low flow sample collection techniques.

A complete description of the sediment and groundwater sampling activities is provided in the Phase I CMS Activities Summary Report which is provided as Attachment 1 to this report.

3.0 ANALYTICAL RESULTS

3.1 GROUNDWATER

Shallow groundwater at the Site is perched and discontinuous and is not used for any purpose. Groundwater samples collected from the shallow groundwater monitoring wells in the north end of the former manufacturing area (MW-2, 7 and 8) gave unfiltered results for total lead in excess of the Indiana Department of Environmental Management (IDEM) Residential Default RISC Criteria (15 ug/L). Analysis of filtered groundwater samples from those wells for lead from the same sampling event were at or below the IDEM Residential Default RISC Criteria. Filtered and unfiltered results for arsenic in MW-1, MW-2, MW-7 and MW-8, and unfiltered results only for MW-3, MW-5 and MW-10 were above the background concentration for arsenic (8.5 µg/l) calculated in the Phase II RFI. No other parameters for MW-2, MW-7 and MW-8 or any of the parameters analyzed for any other well on-site exceeded the IDEM Residential Default RISC Criteria.

3.2 SEDIMENT

Concentrations of lead in the shallow surface sediment samples collected at the depth of 0-3 inches ranged from 617 mg/kg to 14,800 mg/kg and concentrations or arsenic ranged from 12 mg/kg to 169 mg/kg at this depth. Concentrations of lead in the shallow surface sediment samples collected at the depth of 0-6 inches ranged from 411 mg/kg to 874 mg/kg and concentrations of arsenic ranged from 11 mg/kg to 12 mg/kg at this depth. The calculated background for arsenic in shallow surface soil (10.5 mg/kg) was exceeded in all samples. The cleanup level for lead calculated in the Human Health Risk Assessment (Attachment 2)(15,916 m/kg) was not exceeded in these samples.

Concentrations of lead in the subsurface sediment samples collected at the depth of 3-10 inches ranged from 403 mg/kg to 15,700 mg/kg and concentrations of arsenic ranged from 9 mg/kg to 216 mg/kg at this depth. Concentrations of lead in the samples collected at the depth of 6-12 inches ranged from 24 mg/kg to 1,470 mg/kg and concentrations of arsenic ranged from 8.3

mg/kg to 15 mg/kg at this depth. The calculated background concentrations for arsenic in subsurface soil (7.9 mg/kg) was exceeded in all samples. The calculated cleanup level for lead (15,916 mg/kg) was not exceeded in these samples.

4.0 PRELIMINARY RESULTS OF RISK ASSESSMENT

Gradient Corporation (Cambridge, MA) conducted the Baseline Human Health Risk Assessment (Risk Assessment) for RMC. Pursuant to the CMS Work Plan, the Risk Assessment evaluated a variety of exposure scenarios for lead and arsenic for workers at the facility and on the adjacent Citizens Gas property. The evaluation determined that existing arsenic levels at the Site do not present an unacceptable risk for the exposure scenarios evaluated. The lead risk evaluation determined that soil lead concentrations in some areas of the Site create a predicted (95% UCL) blood lead >10ug/dl for the construction worker in the "on-site" area, and for the groundskeeper and plant worker in the "grassy area".

Results of the risk assessment include a Preliminary Remediation Goal (PRG) for each of the exposure scenarios which predict a 95% UCL blood lead >10 ug/dl. The model also provides a Remedial Action Level (RAL), which represents the soil cleanup concentration that will result in remaining soil having an average soil lead concentration less than the PRG. The concept of a RAL is consistent with the adult lead model, which recognizes that the model evaluates exposure on an area wide basis. This means that soils with concentrations exceeding 78,900 mg/kg must be remediated in the "on-site" area to result in an average lead concentration less than 4,601 mg/kg. For the grassy site area (which also includes the wooded areas), the PRG and RAL are 3,195 and 16,700 mg/kg, respectively. The PRG for the Citizens Gas property is 1,840 mg/kg, which is higher than the average soil lead concentration; therefore, no remediation is necessary on the Citizens Gas property.

The complete Baseline Human Health Risk Assessment report is provided as Attachment 2.

5.0 CONCLUSION

Based on the results of the Risk Assessment, arsenic does not pose an unacceptable risk in surface or subsurface soils at the Site. Therefore, no soil remediation is necessary for arsenic.

A conclusion of the Baseline human Health Risk Assessment is that soil remediation is necessary in the "on-site" plant area to remove subsurface soil with total lead concentrations that exceed the calculated RAL of 78,900 mg/kg. Because the exposure scenario assumes a worker who is performing intrusive activities, this standard is being applied to areas with and without pavement.

For the "grass areas", which includes all areas of the site excluding the "on-site" area, the RAL is 16,700 mg/kg for surface soils and no remediation is required for subsurface soils (i.e., soils deeper than 6 inches). Additionally, because the exposure scenario anticipates a non-intrusive use, no removal will be proposed beneath areas of existing pavement. The drainage ditches are considered to be part of the "grass areas" and will therefore be remediated to the 16,700 mg/kg RAL.

ATTACHMENT 1

CORRECTIVE MEASURES STUDY ACTIVITIES SUMMARY REPORT

Prepared For:

REFINED METALS CORPORATION

Prepared By:

ADVANCED GEOSERVICES CORP.
West Chester, Pennsylvania

Project No. 2003-1046-02
June 22, 2004

TABLE OF CONTENTS

PAGE NO.

LIST OF FIGURES

FIGURE

TABLE OF CONTENTS

(Continued)

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 GENERAL

This Corrective Measures Study Activities Summary Report has been submitted by Advanced GeoServices Corp. (AGC) on behalf of Refined Metals Corporation (RMC). This report presents and discusses the methods and procedures used to implement the scope of work as proposed in the Phase II RCRA Facility Investigation (RFI) Report. Groundwater monitoring well installation and sampling activities were conducted by AGC. These activities consisted of installing three piezometers and two groundwater monitoring wells, groundwater sampling and sediment sampling at on-site and off-site locations. Laboratory sample analysis was performed by TriMatrix Laboratories Inc. (TriMatrix) of Grand Rapids, Michigan.

The RMC facility was the location of secondary lead smelting operations from 1968 through 1995. RMC was involved in the reclamation of lead from used automotive and industrial batteries and other lead bearing materials. The Site ceased smelting operations on December 31, 1995. Additional background and facility operation can be found in the Phase II RCRA Facility Investigation Report, dated November 18, 2002.

During its operational life, the facility handled materials that were classified as hazardous materials or hazardous wastes under the Resource Conservation and Recovery Act (RCRA). At this time, the Site is idle except for the wastewater treatment system which remains in operation. The wastewater treatment system remains in place to collect and treat stormwater runoff from the lined lagoon and other Site areas.

2.0 WELL INSTALLATION ACTIVITIES

2.1 INTRODUCTION

Background and facility operation information can be found in the Phase II RCRA Facility Investigation Report, dated November 18, 2002. During the Corrective Measures Study (CMS) three temporary piezometers and two groundwater monitoring wells were installed by Boart Longyear, Environmental Division, from Greensberg, Indiana. The three piezometers were installed using a truck mounted Geoprobe in the area north and east of the former manufacturing area. The piezometers were installed for the purpose of refining groundwater flow prior to selection of locations to install two new wells. Geoprobe borings were advanced into the shallow perched groundwater and the piezometer was constructed using a one (1) inch diameter PVC 0.010 screen. The piezometers were constructed on September 4, 2003 as follows:

	Depth of Boring	Depth of Piezometer	Screen Length	GW Elevation 9/05/2003
GP-1	20'	18.0'	15'	837.63
GP-2	15'	14.8'	10'	839.30
GP-3	25'	23.5'	15'	877.89

Groundwater level measurements were taken from the existing monitoring wells north of the former manufacturing area and piezometers on September 5, 2003 and the locations for two new groundwater-monitoring wells were selected.

The two groundwater monitoring wells were installed between September 8-10, 2003 and designated as MW-10 and MW-11. Groundwater monitoring well MW-10 is located east of MW-2 within the wooded area as shown on Figure 2-1. The depth of the boring for MW-10 was recorded to be 36 feet below ground surface (bgs). Groundwater monitoring well MW-11 is located approximately 156 feet east of MW-8 along the fence line of Arlington Avenue. The

depth of the boring for MW-11 was measured at 30 feet bgs. The locations of both wells installed are shown on Figure 2-1.

2.1.1 Drilling Methods

The soil borings were advanced using hollow stem auger (HSA) techniques and continuous split spoon samples were collected in accordance with ASTM D 1586. The logs for the borings and well construction completed as part of this investigation are included in Appendix A. The samples recovered from the advancement of the deep borings were logged and described using USCS soil classification.

2.1.2 Groundwater Monitoring Well Construction

The monitoring wells were constructed using a 4-inch ID, flush-threaded, Schedule 40 PVC riser with a 10-foot length of factory-slotted 0.010-inch PVC well screen. A sand pack was placed to 2 feet above the top of the monitoring well screen with No. 5 sand. A minimum 2-foot thick bentonite seal was placed on top of the sand pack.

All monitoring wells were completed with a steel protective casing with a locking cap. The protective casing extends from an approximate depth of 3 feet bgs to approximately 2 feet above ground. A neat cement seal was placed around the protective casing to a depth of 2.5 to 3 feet bgs. A 2-foot square well pad was installed so that the surface slopes away from the well.

2.1.3 Groundwater Monitoring Well Development Method

Each groundwater monitoring well installed as part of this Corrective Measures Study field activities were developed using the surge-block and pump method. Groundwater monitoring wells were first surged using a plunger-type surge block assembly. This provides the necessary turbulence in and immediately surrounding the well screen to remove fine-grained material. The wells were then purged and developed by continuous pumping using a electric submersible

pump. Well development ceased when the development water in each well was relatively sediment free, exhibited a satisfactory visual clarity and yield.

2.2 GROUNDWATER SAMPLING

2.2.1 Groundwater Well Evacuation

Following the installation of the two additional groundwater monitoring wells, groundwater samples were collected. The sampling event took place on October 26-29, 2003. Groundwater samples were obtained from groundwater monitoring wells MW-1, MW-2, MW-3, MW-4, MW-5, MW-6SR, MW-7, MW-8, MW-9, MW-10 and MW-11. A total of 11 groundwater samples were collected at the Site (excluding QA/QC samples). A low-flow sampling technique was employed to more accurately determine the potential for site-related constituents which may have entered the groundwater.

Each groundwater monitoring well was purged using a stainless steel low-flow bladder pump placed at the midpoint of the screen in each well. The wells were purged at a flow rate ranging from 100 to 300 milliliters per minute mls/min, depending on the yield of the well. A flow-through cell was used to measure the following field parameters: pH, temperature, conductivity, redox potential, and dissolved oxygen prior to contact with oxygen. These parameters were collected at 3 to 5 minute intervals during purging event. Turbidity was also measured at the same time interval. The wells were purged until the field parameters stabilize to within 10% over three readings and pH readings differ by less than 0.1 unit.

2.2.2 Groundwater Sample Collection

Once the field parameters had stabilized, samples were collected directly from the pump discharge line into laboratory-supplied bottles containing the necessary preservatives at a sampling flow rate of 100 to 300 mls/min.

Sample containers were labeled with a unique identifying number, time and date of sample collection, requested analysis, preservative, and the initials of the sample collector. Samples were packed on ice and shipped to TriMatrix Laboratories Inc. for analysis of eight RCRA metals and antimony (SW-846 6010). Samples for dissolved metals analyses were field filtered through a dedicated disposable Nalgene 0.45 μm membrane filter immediately after collection and prior to preservation. The sample was decanted into the dedicated, Nalgene disposable filtration unit and filtered under vacuum pressure created by a hand-held pump. The sample was then immediately transferred to a laboratory supplied bottleware.

3.0 SEDIMENT SAMPLING

Sediment samples were collected from four locations along the drainage ditch running parallel to Arlington Avenue and from six locations along the CSX rail line drainage ditch. The samples collected along the Arlington Avenue drainage ditch were designated R2SED-11 through R2SED-14. The samples collected along the CSX line were designated R2SB25 through R2SB-30. The location of the sediment samples are presented on Figure 3-1. Sediment was collected at depth intervals of 0-6 inches and 6-12 inches bgs at each of the R2SED locations. Sediment was collected at depth intervals of 0-3 inches and 3-10 inches bgs at each of the R2SB locations. The depth of collection was placed as a suffix to each sample location to delineate in which depth the result is correlated. All sediment samples were collected using decontaminated hand augers. The sediment from each interval was thoroughly homogenized in an aluminum mixing pan and was placed directly into a laboratory supplied jar. Each sediment sample was then placed on ice for shipment and was submitted to TriMatrix to be analyzed for arsenic and lead (EPA Method SW-846 6010B).

4.0 RESULTS

4.1 GROUNDWATER

4.1.1 Groundwater Screening

Arsenic and lead are the two site constituents of concern (COCs) that were detected at levels above the concentrations used for initial groundwater screening purposes. A background concentration was calculated for initial screening of arsenic in groundwater. The background concentrations for arsenic in groundwater has been calculated to be 8.5 μg/l, which is the mean concentration taken from MW-9 plus one standard deviation. The current EPA Region 9 Preliminary Remediation Goals for Tap Water do not provide a standard for lead in groundwater; therefore, we are utilizing the Indiana Department of Environmental Management (IDEM) Residential Default RISC criteria of 15 μg/l. The IDEM Residential Default RISC criteria for arsenic is 50 μg/l.

4.1.2 Groundwater Sampling Results

The analytical results for samples collected from the on-site wells for the groundwater sampling event are presented in Table 4-1. A groundwater surface map is shown as Figure 4-1. October 2003 sample results are provided in Figure 4-2.

Total arsenic was found in groundwater samples at concentrations ranging from 1.3 μg/l in MW-4 to 290 μg/l in MW-7. Arsenic concentrations were detected above the background concentration in MW-1 (24 μg/l), MW-2 (15 μg/l), MW-3 (28 μg/l), MW-5 (8.8 μg/l), MW-7 (290 μg/l), MW-8 (19 μg/l) and MW-10 (24 μg/l). Only MW-7 exceeded the IDEM Residential Default RISC Criteria for arsenic in groundwater.

Total lead was found in groundwater samples at concentrations ranging from below laboratory detection level in MW-1, MW-3, MW-4, MW-10, and MW-11 to 217 µg/l in MW-7. Lead concentrations were detected above the IDEM Residential Default Risk Criteria concentration in MW-2 (44 µg/l), MW-7 (217 µg/l) and MW-8 (55 µg/l). The only filtered sample at or above 15 µgl was MW-8 at a concentration of 15 µgl.

4.2 SEDIMENT

4.2.1 Sediment Screening

Arsenic and lead are the two site constituents of concern (COCs) that were detected at levels above their initial screening levels for soil and sediment. Samples collected from the drainage ditches are referred to as sediment in this report; however, because of the physical character of the material sampled and geomorphic setting, they are compared to the soil standards. The calculated background arsenic in soil concentrations are 10.53 mg/kg for surface soil (0-3 inch) and 7.91 mg/kg (>3 inches) for subsurface soils. Based on the Baseline Human Health Risk Assessment (Attachment 2), the target cleanup level for lead in soil at the Site is 15,916 mg/kg for surface (0-6 inches) soil.

4.2.2 Sediment Sampling Results

The validated analytical results for the sediment samples collected within the drainage ditch along Arlington Avenue and the drainage ditch along the CSX rail line are provided in Table 4-2. The depth of collection was placed as a suffix to each sample location to delineate to show to which depth the result is correlated.

Concentrations of lead in the samples collected at the depth of 0-3 inches ranged from 617 mg/kg at R2SB25 to 14,800 mg/kg at R2SB29, and concentrations of arsenic ranged from 12 mg/kg at R2SB30 to 169 mg/kg at R2SB26 at this depth. The calculated background concentration for

arsenic was exceeded in all samples. The Baseline Human Health Risk Assessment (HHRA) cleanup level for lead was not exceeded in these samples.

Concentrations of lead in the samples collected at the depth of 0-6 inches ranged from 411 mg/kg at R2SED-12 to 874 mg/kg at R2SED-11, and concentrations of arsenic ranged from 11 mg/kg at R2SED-14 and R2SED-12 to 12 mg/kg at R2SED-11 and R2SED-13 at this depth. Table 4-2 presents lead and arsenic results within this depth interval. The calculated background concentration for arsenic was exceeded in all samples. The HHRA cleanup level for lead was not exceeded in these samples.

Concentrations of lead in the samples collected at the depth of 3-10 inches ranged from 403 mg/kg at R2SB28 to 15,700 mg/kg at R2SB29, and concentrations of arsenic ranged from 9 mg/kg at R2SB30 to 216 mg/kg at R2SB29 at this depth. Table 4-2 presents lead and arsenic results within this depth interval. The calculated background concentration for arsenic was exceeded in all samples. The HHRA cleanup level for lead was not exceeded in these samples.

Concentrations of lead in the samples collected at the depth of 6-12 inches ranged from 24 mg/kg at R2SED-14 to 1,470 mg/kg at R2SED-11, and concentrations of arsenic ranged from 8.3 mg/kg at R2SED-13 to 15 mg/kg at R2SED-11 at this depth. The calculated background concentration for arsenic was exceeded in all samples. The HHRA cleanup level for lead was not exceeded in these samples.

5.0 SUMMARY

The following are drawn from the findings of the Corrective Measures Study activities:

Groundwater

- Groundwater flow in the shallow zone of saturation on-site appears to be to the south-southeast.

- Arsenic concentrations exceeded the calculated background concentration in all but four of the samples tested.

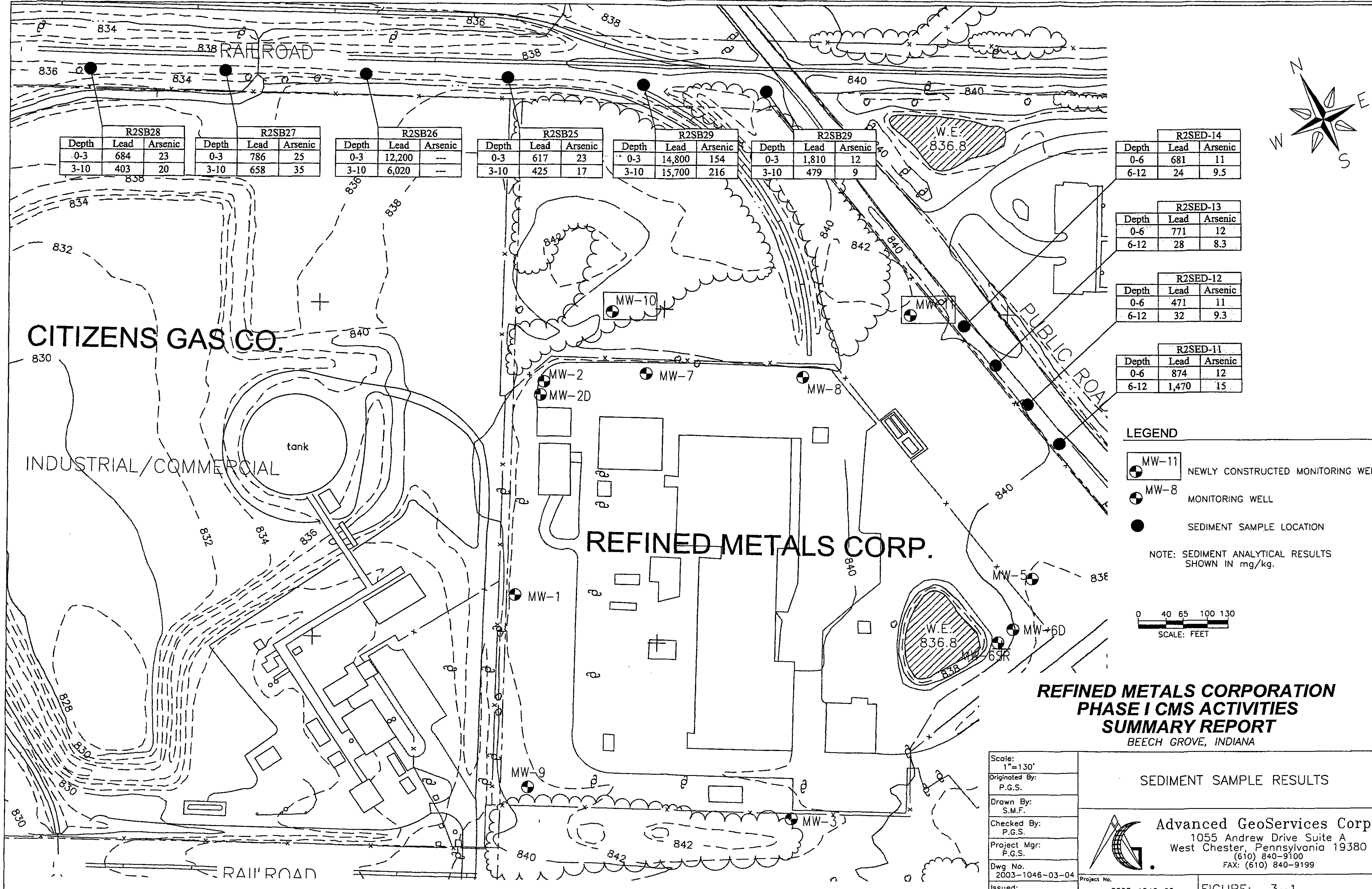
- Lead detected above the IDEM Residential Default RISC Criteria is limited to MW-2S (18 μg/l), MW-7S (217 μg/l) and MW-8S (28 μg/l) immediately north of the manufacturing area where elevated soil lead concentrations exist.

Sediment

- Elevated arsenic in sediment in the drainage ditch along Arlington Avenue and along the CSX line northeast of the Site indicate that off-site transport of sediment may have occurred.

- All sediment sample results for lead are shown to be below the RAL calculated in the Baseline Human Health Risk Assessment.

FIGURES



R2SB28		
Depth	Lead	Arsenic
0-3	684	23
3-10	403	20

R2SB27		
Depth	Lead	Arsenic
0-3	786	25
3-10	658	35

R2SB26		
Depth	Lead	Arsenic
0-3	12,200	---
3-10	6,020	---

R2SB25		
Depth	Lead	Arsenic
0-3	617	23
3-10	425	17

R2SB29		
Depth	Lead	Arsenic
0-3	14,800	154
3-10	15,700	216

R2SB29		
Depth	Lead	Arsenic
0-3	1,810	12
3-10	479	9

R2SED-14		
Depth	Lead	Arsenic
0-6	681	11
6-12	24	9.5

R2SED-13		
Depth	Lead	Arsenic
0-6	771	12
6-12	28	8.3

R2SED-12		
Depth	Lead	Arsenic
0-6	471	11
6-12	32	9.3

R2SED-11		
Depth	Lead	Arsenic
0-6	874	12
6-12	1,470	15

REFINED METALS CORPORATION
PHASE I CMS ACTIVITIES
SUMMARY REPORT
BEECH GROVE, INDIANA

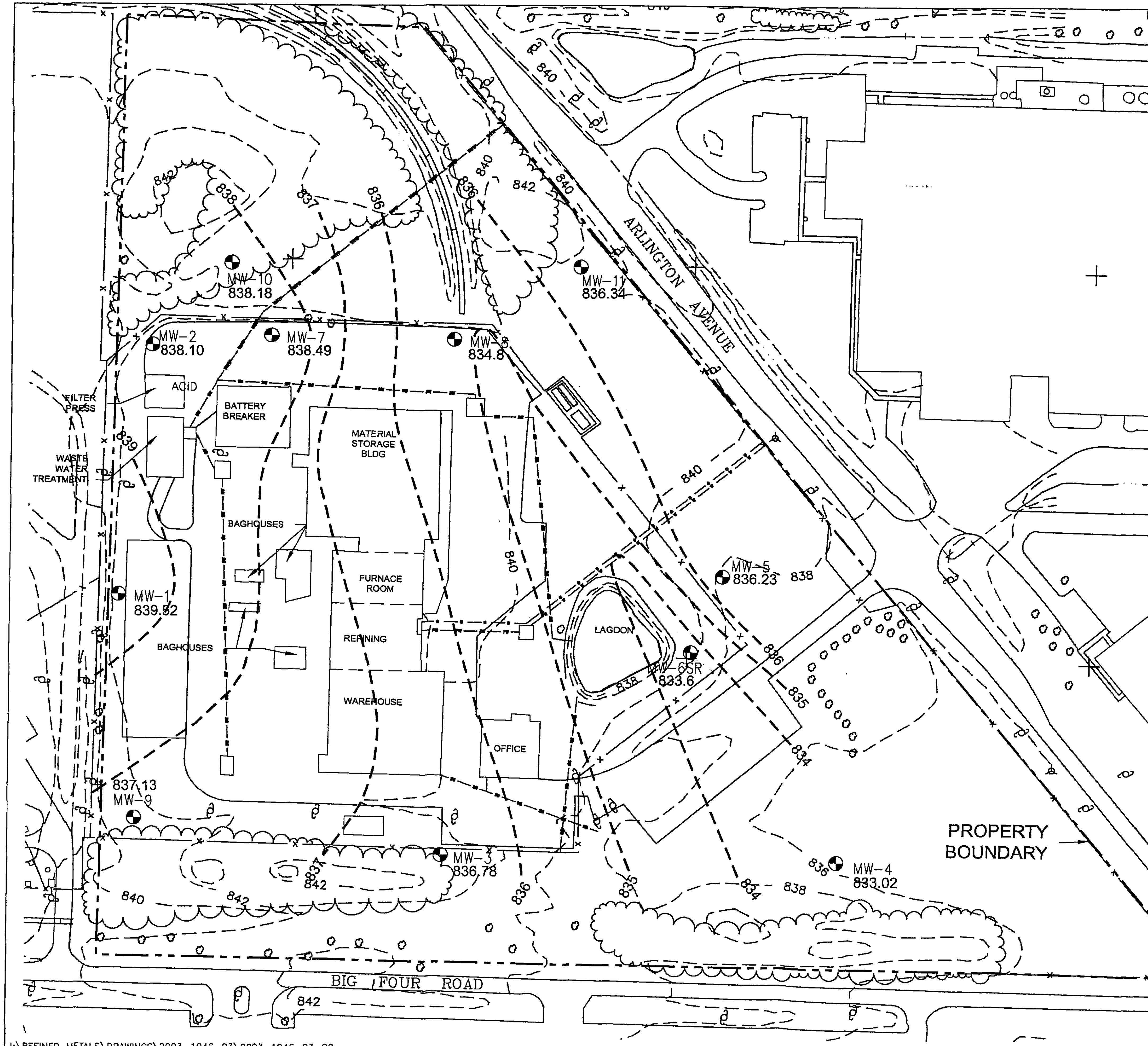
Scale: 1"=130'
Originated By: P.G.S.
Drawn By: S.M.F.
Checked By: P.G.S.
Project Mgr: P.G.S.
Dwg No. 2003-1046-03-04
Issued: JUN 22 2004

SEDIMENT SAMPLE RESULTS

Advanced GeoServices Corp.
1055 Andrew Drive Suite A
West Chester, Pennsylvania 19380
(610) 840-9100
FAX: (610) 840-9199

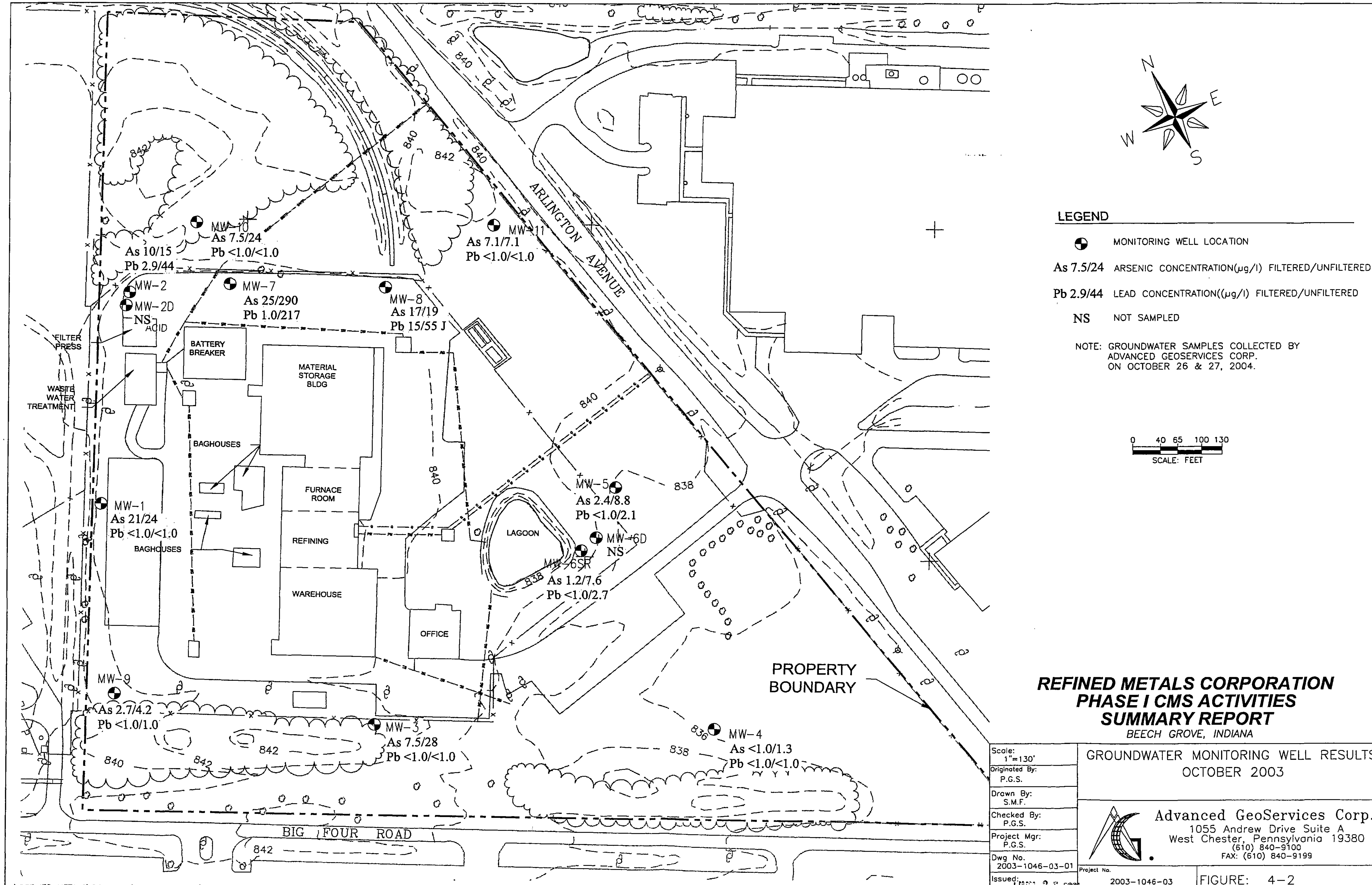
Project No. 2003-1046-03

FIGURE: 3-1



REFINED METALS CORPORATION
PHASE I CMS ACTIVITIES
SUMMARY REPORT
BEECH GROVE, INDIANA

Scale: 1"=130'	SITE MONITORING WELL LOCATIONS AND SHALLOW GROUNDWATER POTENTIOMETRIC MAP OCTOBER 2003
Originated By: K.M.S.	
Drawn By: P.S.G.	
Checked By: P.G.S.	Advanced GeoServices Corp. 1055 Andrew Drive Suite A West Chester, Pennsylvania 19380 (610) 840-9100 FAX: (610) 840-9199
Project Mgr: P.G.S.	
Dwg No. 2003-1046-03-02	
Issued: JUN 2 2 2004	Project No. 2003-1046-03
	FIGURE: 4-1



REFINED METALS CORPORATION
PHASE I CMS ACTIVITIES
SUMMARY REPORT
BEECH GROVE, INDIANA

GROUNDWATER MONITORING WELL RESULTS
OCTOBER 2003

Scale:	1"=130'
Originated By:	P.G.S.
Drawn By:	S.M.F.
Checked By:	P.G.S.
Project Mgr:	P.G.S.
Dwg No.	2003-1046-03-01
Issued:	
Project No.	2003-1046-03

Advanced GeoServices Corp.
1055 Andrew Drive Suite A
West Chester, Pennsylvania 19380
(610) 840-9100
FAX: (610) 840-9199

FIGURE: 4-2

J:\REFINED METALS\DRAWINGS\2003-1046-03\2003-1046-03-01

APPENDIX A

Geoprobe and Monitoring Well Logs

BOART LONGYEAR

FIELD BORING LOG

Sheet 1 Of 1

FOR	Adv. Geoservices	Refined Metals
LOCATION	Beech Grove IN	Elev.

Job No.	3417-1807-36
Boring No.	GP 3

GROUND WATER				
While drilling		Time after drilling		
Before casing removal		Depth to water		
After casing removal		Depth to cave-in		

Start	9/9/03
Unit	837
Chief	Alan

Casing/Probe Weight
Drop

Sample No.	Moisture	Blows on Sampler 0/6	Blows on Sampler 6/12	Sample Rec.	Total Blows	Depth	VISUAL FIELD CLASSIFICATION AND REMARKS	Depth	Unconfined Strength	Boulders	Blows on Casing Size	Blows on Probe Size	Drilling Method
							Topsoil						6 1/4 H.S.A
							Firm gray-~~gray~~ brown mottled silty clay (dry)						
							8.0'						
							Firm brown silty clay with gravel (dry)						
							13.5'						
							Stiff gray silty ~~sandy~~ CLAY (moist)						
							16.0'						
							Gray sandy clay (wet) 17.0'						
							Stiff gray brown silty clay (dry)						
						20	Same 20.0'	20					
							No Recovery, sand ~~in~~ trapped in sample sleeve. some standing water in hole at 18'						
						25	25.0	25					
							EOB 25'						

BOART LONGYEAR — **FIELD BORING LOG** — Sheet 1 Of 1

FOR Adv. Geoservices Refined Metals

LOCATION Beech Grove IN Elev.

Job No. 3417-1807-36

Boring No. GP 2

GROUND WATER				
While drilling	5.0'	Time after drilling		
Before casing removal	NA	Depth to water		
After casing removal	NA	Depth to cave-in		

Start 9/9/03
Unit 837
Chief Alan

Casing/Probe NA
Weight NA
Drop NA

Sample No.	Moisture	Blows on Sampler 0/6	Blows on Sampler 6/12	Sample Rec.	Total Blows	Depth	VISUAL FIELD CLASSIFICATION AND REMARKS	Depth	Unconfined Strength	Boulders	Blows on Casing Size	Blows on Probe Size	Drilling Method
							Soft dark gray Topsoil 1.0'						6 1/4
							Hard brown gray mottled silty clay (dry) ~~Clay~~						H.S.A
							becoming ~~wet~~ moist at 3'						
						5	5.0'	5					
							Wet Sand 6.0						
							Stiff tan/brown mottled clay with gravel						
							~~Same~~						
						10		10					
							~~stiff~~ brown gray mottled clay						
							~~Sand~~						
							~~St~~ Stiff gray clay with gravel and small cobbles						
						15		15					
							EOB 15'						
						20		20					
						25		25					
						30		30					
						35		35					
						40		40					
						45		45					
						50		50					

BOART LONGYEAR — **FIELD BORING LOG** — Sheet 1 Of 1

FOR	Adv. Geoservices — Refined Metals
LOCATION	Beech Grove IN
Elev.	
Job No.	3417-1807-36
Boring No.	GP 1

GROUND WATER					
While drilling	13.0'	Time after drilling		Start	9/9/03
Before casing removal	NA	Depth to water		Unit	837
After casing removal	NA	Depth to cave-in	15'	Chief	Alan

Casing/Probe NA
Weight NA
Drop NA

Sample No.	Moisture	Blows on Sampler 0/6	Blows on Sampler 6/12	Sample Rec.	Total Blows	Depth	VISUAL FIELD CLASSIFICATION AND REMARKS	Depth	Unconfined Strength	Boulders	Casing Size	Probe Size	Drilling Method
							Topsoil						~~5 1/4~~
							Soft tan/brown silty ~~Clay~~ Clay (moist)						~~H.S.A.~~ Geop.
						5		5.0' 5					
							Soft tan/brown to gray silty Clay (with rounded gravel below 6') dry ~~Same~~						
						10		10.5' 10					
							Gravel and Clay seam (moist) ~~Same~~	10.7'					
							Stiff brown silty Clay with gravel (moist) (wet below 13.0')	▽ 13.0'					
						15		15.2' 15					
							Brown gray silty ~~Sand~~ Sand (saturated)						
								19.0'					
						20	Hard gray Clay with gravel (dry)	20.0' 20					
							EOB 20'						
						25		25					
						30		30					
						35		35					
						40		40					
						45		45					
						50		50					

BOART LONGYEAR

FIELD BORING LOG

Sheet 1 Of 1

FOR Adv. Geoservices Refined Metals

Job No. 3417-1807-36

LOCATION Beech Grove IN Elev.

Boring No. MW 10

GROUND WATER	While drilling		Time after drilling		Start 9/9/03
	Before casing removal		Depth to water		Unit 822
	After casing removal		Depth to cave-in		Chief Dan

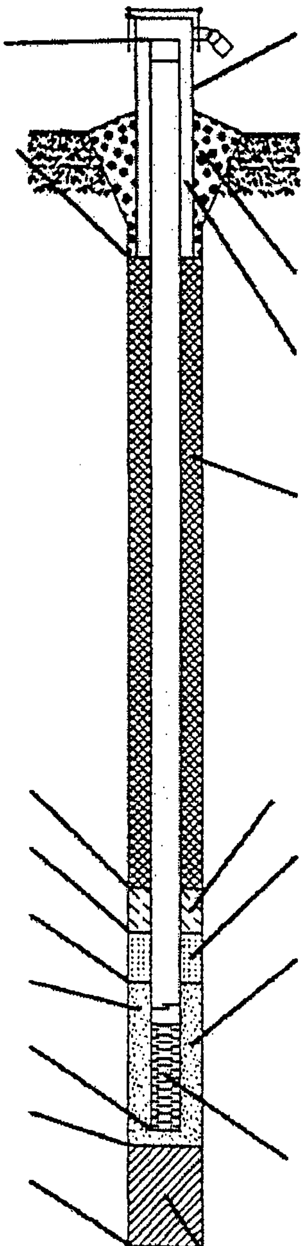
Casing/Probe Weight Drop

Sample No.	Moisture	Blows on Sampler 0/6	Blows on Sampler 6/12	Sample Rec.	Total Blows	Depth	VISUAL FIELD CLASSIFICATION AND REMARKS	Depth	Unconfined Strength	Boulders	Blows on Casing Size	Blows on Probe Size	Drilling Method
							Topsoil						6 1/4
							Br. Silty Clay						H.S.A
						5		5					
1	D	5	8										
		12	12	2.0	20								
						10	M-C Br. Sand w/ Gravel	10					
2	W	7	34				Gray Silty Clay						
		45	25	1.5	79								
						15		15					
3	W	5	17				Gray Silty Clay						
		43	46	1.5	60								
4	W	10	20										
		25	26	1.2	45								
5	W	10	23			20		20					
		27	30	1.5	60								
6	W	8	10										
		14	16	1.2	24								
							EOB 23'						
						25	Set Well @ 19'	25					
						30		30					
						35		35					
						40		40					
						45		45					
						50		50					

BOART LONGYEAR
Well Construction Report

Job Name	Refined Metals	**Well Name**	MW-10
Job Number	3417-1807-36	**Driller**	D. Harrison
Location	Beech Grove, IN	**Helper**	
		Date Installed	09/09/03

Type of Well:
X Water Table Observation
___ Piezometer
___ Other ___



A. Height of Well Casing above ground 3.0 ft.

B. Diameter of Well Casing 4.0 in.

C. Surface Seal Bottom 1.0 ft.

D. Well Casing: Flush Threaded PVC
X Schedule 40
___ Schedule 80
___ Other ___

E. Bentonite Seal Top 2.0 ft.

F. Fine Sand Top ___ ft.

G. Filter Pack Top 7.0 ft.

H. Screen Joint Top 9.0 ft.

I. Well Bottom 19.0 ft.

J. Filter Pack Bottom 19.0 ft.

K. Borehole Bottom 23.0 ft.

1. Locking Cap? X Yes ___ No
2. Protective Cover: a. Inside diam. 6.0 in.
   b. Length 5.0 ft.
   c. Material
   X Steel
   ___ Other ___
   d. Bumper Post No qty
   ___ 3" ___ 4"
3. Surface Seal: ___ Bentonite
   X Concrete
   ___ Other ___
4. Material between Casing and Protop:
   ___ Bentonite
   ___ Other ___
5. Annular Space Seal:
   ___ Granular Bentonite
   ___ Bentonite Slurry
   ___ Cement-Bentonite Grout
   ___ Other ___
   How Installed:
   ___ Gravity
   ___ Tremie Pumped
6. Bentonite Seal:
   X Granules
   ___ Pellets
7. Type of Fine Sand:
   ___
8. Type of Filter Pack:
   #5
9. Screen Material: PVC
   Type: X Factory Cut
   ___ Continuous Slot
   Slot Size: 0.010 in.
   Length: 10.0 ft.
10. Backfill Material: (Below filter pack)
   ___ None
   X Other Sand

Boart Longyear
5815 Churchman Ave., Suite 2
Indianapolis, IN 46203
Phone (317) 784-1838
Fax (317) 784-2035

BOART LONGYEAR

FIELD BORING LOG

Sheet 1 Of 1

FOR Adv. Geoservices Refined Metals

LOCATION Beech Grove IN Elev.

Job No. 3417-1807-36

Boring No. MW 11

GROUND WATER: While drilling / Before casing removal / After casing removal

Time after drilling / Depth to water / Depth to cave-in

Start 9/9/03

Unit 822

Chief Dan

Casing/Probe Weight / Drop

Sample No.	Moisture	Blows on Sampler 0/6	Blows on Sampler 6/12	Sample Rec.	Total Blows	Depth	VISUAL FIELD CLASSIFICATION AND REMARKS	Unconfined Strength	Boulders	Casing Size	Probe Size	Drilling Method
							Topsoil					6 1/4
							Br. Silty Clay					H.S.A
						5						
1		8	19									
		42	36	1.8	61							
						10						
2		10	12									
		18	15	1.8	30							
						15						
3		10	24				M-C Sand					
		10	17	1.2	34		Br. Silty Clay					
4		12	17									
		34	75	1.2	51							
5		15	59			20	M-F Br. Silty Sand					
		69	58	1.5	128							
6		15	19				Gray M-F Sand					
		20	23	1.8	39							
							EOB 23'					
						25	Set Well @ 23'					
						30						
						35						
						40						
						45						
						50						

BOART LONGYEAR
Well Construction Report

Job Name: Refined Metals
Job Number: 3417-1807-36
Location: Beech Grove, IN

Well Name: MW-11
Driller: D. Harrison
Helper: ____
Date Installed: 09/09/03

Type of Well:
X Water Table Observation
__ Piezometer
__ Other ____

A. Height of Well Casing above ground
3.0 ft.

B. Diameter of Well Casing
4.0 in.

C. Surface Seal Bottom
1.0 ft.

D. Well Casing: Flush Threaded PVC
X Schedule 40
__ Schedule 80
__ Other ____

E. Bentonite Seal Top 2.0 ft.

F. Fine Sand Top ____ ft.

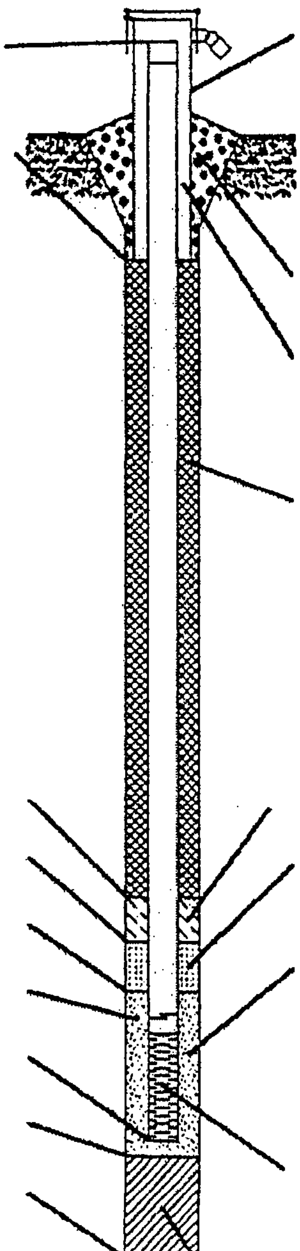
G. Filter Pack Top 10.5 ft.

H. Screen Joint Top 13.0 ft.

I. Well Bottom 23.0 ft.

J. Filter Pack Bottom 23.0 ft.

K. Borehole Bottom 23.0 ft.



1. Locking Cap? X Yes __ No

2. Protective Cover:
   a. Inside diam. 6.0 in.
   b. Length 5.0 ft.
   c. Material
      X Steel
      __ Other ____
   d. Bumper Post No qty
      __ 3" __ 4"

3. Surface Seal:
   __ Bentonite
   X Concrete
   __ Other ____

4. Material between Casing and Protop:
   __ Bentonite
   __ Other ____

5. Annular Space Seal:
   __ Granular Bentonite
   __ Bentonite Slurry
   __ Cement-Bentonite Grout
   __ Other ____

   How Installed:
   __ Gravity
   __ Tremie Pumped

6. Bentonite Seal:
   __ Granules
   __ Pellets

7. Type of Fine Sand:
   ____

8. Type of Filter Pack:
   #5

9. Screen Material: PVC
   Type: X Factory Cut
   __ Continuous Slot
   Slot Size: 0.010 in.
   Length: 10.0 ft.

10. Backfill Material: (Below filter pack)
   __ None
   __ Other ____

Boart Longyear
5815 Churchman Ave., Suite 2
Indianapolis, IN 46203
Phone (317) 784-1838
Fax (317) 784-2035

APPENDIX B

Sediment Sampling Data
October 2003 Groundwater Data

TABLE 4-1
Groundwater Sampling,
10/26 - 10/28/2003

Sample Location		MW-4			MW-6			MW-3			MW-3D			MW-5			EB-1-102603			MW-11			MW-7S		
Lab ID		348075			348076			348077			348078			348079			348080			348081			348082		
Sample Date		10/26/2003			10/26/2003			10/26/2003			10/26/2003			10/26/2003			10/26/2003			10/27/2003			10/27/2003		
Matrix		Groundwater			Groundwater			Groundwater			Groundwater			Groundwater			Aqueous			Groundwater			Groundwater		
Remarks											FD of MW-3						Equipment Blank								
Parameter	**Units**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**
Total Metals																									
Antimony	ug/L		U	10		U	10		U	10		U	10		U	10		U	10		U	10		U	10
Arsenic	ug/L	1.3		1	7.6		1	28		1	27		1	8.8		1		U	1	7.1		1	290		1
Barium	ug/L	276		10	228		10	84		10	80		10	159		10		U	10	167		10	17		10
Cadmium	ug/L		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Chromium	ug/L		U	1	4.5		1		U	1		U	1	1.1		1		U	1	1.1		1	1.9		1
Lead	ug/L		U	1	2.7		1		U	1		U	1	2.1		1		U	1		U	1	217		1
Mercury	ug/L		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Selenium	ug/L		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2
Silver	ug/L		U	0.2		U	0.2		U	0.2	0.2		0.2		U	0.2		U	0.2		U	0.2		U	0.2
Dissolved Metals																									
Antimony	ug/L		U	10		U	10		U	10		U	10		U	10		U	10		U	10		U	10
Arsenic	ug/L		U	1	1.2		1	7.5		1	7.7		1	2.4		1		U	1	7.1		1	25		1
Barium	ug/L	213		10	117		10	73		10	76		10	154		10		U	10	167		10	15		10
Cadmium	ug/L		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Chromium	ug/L	2.1		1	2.1		1	4.9		1	4.6		1	2.2		1		U	1		U	1	7.4		1
Lead	ug/L		U	1		U	1		U	1		U	1		U	1		U	1		U	1	1		1
Selenium	ug/L		U	2		U	2	2		2		U	2		U	2		U	2		U	2		U	2

TABLE 4-1
Groundwater Sampling,
10/26 - 10/28/2003

Sample Location		MW-9			MW-1			MW-2			FB-1-102703			MW-10			MW-8S			MW-8SD			EB-2-102803		
Lab ID		348083			348084			348085			348086			348087			348088			348089			348090		
Sample Date		10/27/2003			10/27/2003			10/27/2003			10/27/2003			10/28/2003			10/28/2003			10/28/2003			10/28/2003		
Matrix		Groundwater			Groundwater			Groundwater			Aqueous			Groundwater			Groundwater			Groundwater			Aqueous		
Remarks											Field Blank									FD of MW-8S			Equipment Blank		
Parameter	**Units**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**	**Result**	**Q**	**RL**
Total Metals																									
Antimony	ug/L		U	10		U	10		U	10		U	10		U	10		U	10		U	10		U	10
Arsenic	ug/L	4.2		1	24		1	15		1		U	1	24		1	19		1	18		1		U	1
Barium	ug/L	43		10	69		10	44		10		U	10	71		10	89		10	83		10		U	10
Cadmium	ug/L		U	0.2		U	0.2	0.2		0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Chromium	ug/L		U	1	1.3		1	2.1		1		U	1	1.6	U	1	1.1	U	1	1.5	U	1	1.2		1
Lead	ug/L	1		1		U	1	44		1		U	1		U	1	55	J	1	35	J	1		U	1
Mercury	ug/L		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Selenium	ug/L		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2		UJ	2
Silver	ug/L		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Dissolved Metals																									
Antimony	ug/L		U	10		U	10		U	10		U	10		U	10		U	10		U	10		U	10
Arsenic	ug/L	2.7		1	21		1	10		1		U	1	7.5		1	17		1	16		1		U	1
Barium	ug/L	41		10	69		10	22		10		U	10	16		10	79		10	76		10		U	10
Cadmium	ug/L		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Chromium	ug/L	1.9		1	6.5		1	3.1		1		U	1	5.2		1	2.9		1	2.8		1		U	1
Lead	ug/L		U	1		U	1	2.9		1		U	1		U	1	15		1	12		1		U	1
Selenium	ug/L		U	2		U	2		U	2		U	2	2.3		2		U	2		U	2		U	2

TABLE 4-2
Sediment Sampling,
10/28 - 10/29/2003

Sample Location	Lab ID	Sample Date	Matrix	Remarks	Parameter	Units	Result	Q	RL
Arsenic									
R2SED-11-0-6	348091	10/28/2003	Sediment		Arsenic	mg/kg	12		1
R2SED-11-6-12	348092	10/28/2003	Sediment		Arsenic	mg/kg	15		1
R2SED-12-0-6	348093	10/28/2003	Sediment		Arsenic	mg/kg	11		1
R2SED-12D-0-6	348094	10/28/2003	Sediment	FD of R2SED-12-0-6	Arsenic	mg/kg	12		1
R2SED-12-6-12	348095	10/28/2003	Sediment		Arsenic	mg/kg	9.3		1
R2SED-13-0-6	348096	10/28/2003	Sediment		Arsenic	mg/kg	12		1
R2SED-13-6-12	348097	10/28/2003	Sediment		Arsenic	mg/kg	8.3		1
R2SED-14-0-6	348098	10/28/2003	Sediment		Arsenic	mg/kg	11		1
R2SED-14-6-12	348099	10/28/2003	Sediment		Arsenic	mg/kg	9.5		1
R2SB30-0-3	348101	10/29/2003	Sediment		Arsenic	mg/kg	12		1
R2SB30-3-10	348102	10/29/2003	Sediment		Arsenic	mg/kg	9		1
R2SB29-0-3	348103	10/29/2003	Sediment		Arsenic	mg/kg	154		25
R2SB29-3-10	348104	10/29/2003	Sediment		Arsenic	mg/kg	216		25
R2SB25-0-3	348105	10/29/2003	Sediment		Arsenic	mg/kg	23		1
R2SB25-3-10	348106	10/29/2003	Sediment		Arsenic	mg/kg	17		1
R2SB26-0-3	348107	10/29/2003	Sediment		Arsenic	mg/kg	169		25
R2SB26-3-10	348108	10/29/2003	Sediment		Arsenic	mg/kg	114		25
R2SB27-0-3	348109	10/29/2003	Sediment		Arsenic	mg/kg	25		1
R2SB27-3-10	348110	10/29/2003	Sediment		Arsenic	mg/kg	35		1
R2SB28-0-3	348111	10/29/2003	Sediment		Arsenic	mg/kg	23		1
R2SB28-3-10	348112	10/29/2003	Sediment		Arsenic	mg/kg	20		1
R2SB28D-3-10	348113	10/29/2003	Sediment	FD of R2SB28-3-10	Arsenic	mg/kg	22		1
EB-4-102903	348114	10/29/2003	Aqueous	Equipment Blank	Arsenic	ug/L		U	1
Lead									
R2SED-11-0-6	348091	10/28/2003	Sediment		Lead	mg/kg	874		120
R2SED-11-6-12	348092	10/28/2003	Sediment		Lead	mg/kg	1470		300
R2SED-12-0-6	348093	10/28/2003	Sediment		Lead	mg/kg	411		60
R2SED-12D-0-6	348094	10/28/2003	Sediment	FD of R2SED-12-0-6	Lead	mg/kg	462		60
R2SED-12-6-12	348095	10/28/2003	Sediment		Lead	mg/kg	32		0.6
R2SED-13-0-6	348096	10/28/2003	Sediment		Lead	mg/kg	771		120
R2SED-13-6-12	348097	10/28/2003	Sediment		Lead	mg/kg	28		0.6
R2SED-14-0-6	348098	10/28/2003	Sediment		Lead	mg/kg	681		60
R2SED-14-6-12	348099	10/28/2003	Sediment		Lead	mg/kg	24		0.6
R2SB30-0-3	348101	10/29/2003	Sediment		Lead	mg/kg	1810		300
R2SB30-3-10	348102	10/29/2003	Sediment		Lead	mg/kg	479		60
R2SB29-0-3	348103	10/29/2003	Sediment		Lead	mg/kg	14800		3000
R2SB29-3-10	348104	10/29/2003	Sediment		Lead	mg/kg	15700		3000
R2SB25-0-3	348105	10/29/2003	Sediment		Lead	mg/kg	617		60
R2SB25-3-10	348106	10/29/2003	Sediment		Lead	mg/kg	425		60
R2SB26-0-3	348107	10/29/2003	Sediment		Lead	mg/kg	12200		1200
R2SB26-3-10	348108	10/29/2003	Sediment		Lead	mg/kg	6020		600
R2SB27-0-3	348109	10/29/2003	Sediment		Lead	mg/kg	786		120
R2SB27-3-10	348110	10/29/2003	Sediment		Lead	mg/kg	658		120
R2SB28-0-3	348111	10/29/2003	Sediment		Lead	mg/kg	684		120
R2SB28-3-10	348112	10/29/2003	Sediment		Lead	mg/kg	403		60
R2SB28D-3-10	348113	10/29/2003	Sediment	FD of R2SB28-3-10	Lead	mg/kg	490		60
EB-4-102903	348114	10/29/2003	Aqueous	Equipment Blank	Lead	ug/L		U	1

Well ID: MW-1 Job No: 98-478-04

Date Sampled: 10/27/2003

Sampled by: BAC

Well Diameter: 2"

DTW: 7.47

DTB: 31.56

Estimated Pump Setting: 26'

Estimated Flow Rate: 140 ml/min

Sample Collection Time: 1412

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1257	6.74	5.40	1.325	12.95	134	195.0
1300	6.79	2.62	1.51	12.66	107	340
1303	6.79	1.93	1.55	12.84	81	385
1307	6.79	1.34	1.55	13.57	58	476
1310	6.78	1.20	1.55	13.70	52	403
1314	6.79	0.87	1.54	13.73	40	270
1318	6.79	0.74	1.55	13.76	32	152.3
1321	6.79	0.67	1.54	13.55	27	98.9
1324	6.79	0.66	1.55	13.58	25	79.0
1327	6.79	0.62	1.55	13.54	21	64.8
1330	6.79	0.59	1.55	13.63	18	51.6
1333	6.79	0.57	1.55	13.67	15	47.3
1336	6.78	0.56	1.55	13.76	13	39.0
1339	6.78	0.53	1.55	13.75	11	33.6
1342	6.79	0.52	1.55	14.00	10	28.4
1345	6.79	0.52	1.55	14.06	8	20.3
1348	6.78	0.49	1.56	14.48	-3	17.5
1400	6.78	0.48	1.56	14.38	-3	15.4
1403	6.79	0.48	1.55	13.84	-5	15.2
1406	6.78	0.47	1.56	13.92	-5	14.8
1409	6.78	0.46	1.56	14.30	-6	14.2
1416	6.81	1.58	1.56	13.98	74	28.5

Comments 3.0 gal removed

Well ID: MW-2 Job No: 98-478-04

Date Sampled: 10/27/2003

Sampled by: BAC

Well Diameter: 2"

DTW: 8.8

DTB: 31.36

Estimated Pump Setting: 26'

Estimated Flow Rate: 180 ml/min

Sample Collection Time: 1540

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1438	6.72	3.08	1.90	14.58	60	83.9
1441	6.72	1.75	1.91	14.14	47	88.1
1444	6.71	1.50	1.90	13.70	44	93.9
1448	6.70	1.11	1.89	14.61	35	58.7
1451	6.70	1.05	1.90	14.78	34	53.3
1454	6.70	0.95	1.91	15.19	28	44.7
1458	6.71	0.84	1.92	15.06	21	30.3
1502	6.71	0.75	1.92	14.46	15	21.6
1506	6.71	0.70	1.93	14.44	12	17.8
1509	6.71	0.68	1.93	14.33	10	15.1
1512	6.72	0.66	1.93	14.38	9	13.6
1515	6.72	0.65	1.93	14.43	8	12.2
1518	6.71	0.64	1.93	14.48	7	11.1
1521	6.71	0.62	1.93	14.28	5	9.8
1524	6.71	0.61	1.93	14.29	4	9.6
1527	6.72	0.59	1.93	13.91	2	8.4
1530	6.72	0.58	1.94	13.94	2	8.1
1533	6.71	0.58	1.93	13.97	1	8.0
1546	6.71	1.03	1.91	14.70	62	15.3

Comment: 3.0 gal removed

Well ID:	MW-3	Job No:	98-478-04
Date Sampled:	10/26/2003		
Sampled by:	BAC		
Well Diameter:	2"		
DTW:	11.28		
DTB:	22.36		
Estimated Pump Setting:	17'		
Estimated Flow Rate:	210 ml/min		
Sample Collection Time:	1415		

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1312	6.97	2.84	1.367	13.40	101	962
1315	6.95	1.62	1.389	13.82	88	957
1318	6.94	1.11	1.389	13.96	76	1058
1321	6.93	1.17	1.389	13.90	74	1108
1325	6.95	0.87	1.391	13.95	67	838
1330	6.94	0.75	1.392	13.77	56	536
1334	6.94	0.77	1.392	13.57	52	366
1337	6.95	0.74	1.392	13.46	51	362
1340	6.94	0.70	1.391	13.27	46	277
1343	6.95	0.70	1.391	13.24	46	291
1346	6.95	0.65	1.390	13.19	42	261
1349	6.96	0.64	1.390	13.16	40	179.1
1352	6.96	0.64	1.389	13.33	38	171.3
1355	6.96	0.65	1.387	13.29	36	173.8
1358	6.95	0.66	1.386	13.87	36	137.8
1401	6.96	0.65	1.387	13.87	34	122.9
1404	6.95	0.59	1.387	13.38	31	92.7
1407	6.95	0.57	1.388	13.36	28	82.1
1410	6.96	0.56	1.388	13.35	26	90.3
1413	6.96	0.54	1.389	13.39	25	84.1

Comment: Removed 3.0 gal

Well ID: MW-4 Job No: 98-478-04

Date Sampled: 10/26/2003

Sampled by: BAC

Well Diameter: 2"

DTW: 6

DTB: 23.97

Estimated Pump Setting: 19'

Estimated Flow Rate: 200ml/min

Sample Collection Time: 1130

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1024	7.02	3.96	0.806	14.11	365	1149
1028	7.03	1.67	0.814	14.71	283	668
1032	7.03	1.26	0.816	14.40	189	473
1036	7.02	1.14	0.814	14.02	125	447
1040	7.02	1.09	0.814	14.13	107	380
1044	7.01	1.01	0.816	14.36	89	310
1048	7.00	0.94	0.817	14.54	78	233
1052	7.00	0.89	0.819	14.36	73	128.9
1056	7.00	0.85	0.820	14.45	69	127.6
1100	7.00	0.81	0.821	14.35	65	185.3
1104	7.00	0.78	0.821	14.73	61	178.6
1108	7.00	0.75	0.822	14.61	60	261.0
1112	6.99	0.73	0.824	14.62	55	120.6
1116	6.99	0.68	0.825	14.97	52	91.6
1120	7.00	0.66	0.825	14.7	48	61.7
1123	6.99	0.65	0.825	14.53	47	52.9
1126	6.99	0.62	0.826	14.82	45	55.8
1129	6.98	0.61	0.827	15.07	44	54.4

Commen Removed 3.0 gal

Well ID: MW-5 Job No: 98-478-04

Date Sampled: 10/26/2003

Sampled by: BAC

Well Diameter: 2"

DTW: 4.61

DTB: 26.25

Estimated Pump Setting: 21'

Estimated Flow Rate: 170 ml/min

Sample Collection Time: 1612

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1445	7.16	4.15	0.759	13.29	178	413
1448	7.10	2.99	0.768	13.55	159	531
1451	7.09	2.17	0.777	13.54	150	603
1454	7.08	1.47	0.782	13.53	146	568
1457	7.09	1.39	0.781	13.52	145	406
1501	7.09	1.25	0.781	13.68	146	216
1505	7.09	1.20	0.783	13.75	145	142.1
1509	7.09	0.96	0.791	13.64	140	640
1513	7.08	0.93	0.790	13.60	140	529
1516	7.07	0.89	0.791	13.44	139	244
1519	7.07	0.87	0.791	13.35	138	151.5
1522	7.08	0.81	0.791	13.21	134	89.7
1525	7.07	0.77	0.791	13.09	131	125.0
1528	7.06	0.75	0.792	12.99	128	149.3
1531	7.07	0.72	0.792	12.98	126	295
1534	7.07	0.71	0.792	12.85	124	226
1537	7.08	0.71	0.792	12.65	123	118.3
1540	7.07	0.71	0.791	12.50	121	110.6
1543	7.07	0.70	0.793	12.41	120	64.7
1547	7.07	0.67	0.794	12.10	115	46.8
1551	7.07	0.66	0.795	12.08	115	38.8
1555	7.07	0.65	0.794	12.12	112	28.0
1600	7.08	0.65	0.795	12.10	110	26.1
1603	7.07	0.65	0.793	12.09	110	21.3
1606	7.08	0.64	0.793	12.20	109	20.8
1609	7.08	0.62	0.793	12.30	107	19.9
1615	7.08	1.81	0.806	13.03	167	65.3

Comment: 4.0 gal removed

Well ID: MW-6 Job No: 98-478-04

Date Sampled: 10/26/2003

Sampled by: BAC

Well Diameter: 4"

DTW: 11.65

DTB: 31.8

Estimated Pump Setting: 27'

Estimated Flow Rate: 160 ml/min

Sample Collection Time: 1244

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1149	7.19	4.14	0.884	14.07	194	184.4
1152	7.18	3.36	0.889	13.59	171	142.0
1155	7.19	2.88	0.889	13.00	153	127.5
1159	7.22	2.30	0.879	13.05	128	110.0
1203	7.22	2.03	0.877	13.56	122	119.3
1207	7.24	1.38	0.870	13.71	98	117.9
1211	7.26	1.19	0.866	13.04	83	102.9
1214	7.27	1.12	0.865	13.10	80	101.4
1217	7.25	1.08	0.867	13.21	78	104.5
1220	7.24	1.05	0.874	13.18	76	114.7
1223	7.18	1.00	0.882	13.50	73	130.2
1226	7.18	0.90	0.884	13.47	71	132.1
1229	7.19	0.84	0.878	13.24	68	125.6
1232	7.20	0.80	0.875	13.11	65	118.6
1235	7.20	0.78	0.876	13.12	64	117.0
1238	7.21	0.76	0.873	13.12	63	114.6
1241	7.20	0.76	0.878	12.97	62	115.6
1250	7.21	1.03	0.863	13.34	135	135.6

Comment: Removed 2.5 gal

Well ID:	MW-7[illegible]	Job No: 98-478-04
Date Sampled:	10/27/2003	
Sampled by:	BAC	
Well Diameter:	4"	
DTW:	6.12	
DTB:	24.62	
Estimated Pump Setting:	19'	
Estimated Flow Rate:	210 ml/min	
Sample Collection Time:	1110	

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1000	6.44	1.91	4.19	14.94	157	132.5
1003	6.44	1.11	4.20	15.19	126	144.2
1006	6.43	1.08	4.19	14.85	119	145.7
1010	6.43	0.98	4.18	14.98	112	166.2
1014	6.44	0.84	4.12	15.08	103	265
1018	6.44	0.84	4.10	14.81	98	304
1022	6.45	0.82	4.06	14.52	92	376
1026	6.45	0.76	4.04	15.21	88	456
1029	6.45	0.70	3.98	15.21	82	490
1032	6.45	0.65	3.95	15.43	76	522
1035	6.46	0.64	3.95	15.40	75	516
1038	6.46	0.64	3.94	15.24	73	502
1041	6.46	0.63	3.95	15.28	69	481
1044	6.46	0.63	3.93	15.37	67	440
1047	6.46	0.60	3.92	15.53	63	405
1050	6.46	0.60	3.92	15.31	60	366
1053	6.46	0.59	3.92	14.83	58	343
1056	6.46	0.58	3.92	14.69	55	312
1059	6.46	0.56	3.93	14.71	52	293
1102	6.46	0.55	3.92	15.07	50	254
1105	6.46	0.55	3.91	14.99	49	248
1108	6.46	0.54	3.92	15.03	47	242
1115	6.46	0.67	3.91	15.45	43	136.7

Comment: 4.0 gal removed

Well ID:	MW-8	Job No: 98-478-04
Date Sampled:	10/28/2003	
Sampled by:	BAC	
Well Diameter:	4"	
DTW:	8.75	
DTB:	29.18	
Estimated Pump Setting:	24'	
Estimated Flow Rate:	190 ml/min	
Sample Collection Time:	1040	

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
954	7.26	2.13	1.097	14.09	16	25.3
957	7.24	1.55	1.080	14.12	23	18.0
1000	7.25	1.43	1.079	13.59	30	15.5
1003	7.25	1.31	1.076	14.05	34	12.6
1006	7.25	1.22	1.075	14.02	38	12.3
1010	7.27	1.11	1.074	14.05	41	11.6
1014	7.27	1.10	1.072	14.04	42	11.1
1018	7.26	1.03	1.058	14.06	44	9.3
1022	7.25	1.02	1.058	14.09	45	9.4
1025	7.26	0.98	1.051	13.97	45	8.9
1028	7.25	0.98	1.046	14.01	46	8.4
1031	7.23	0.92	1.033	14.12	45	6.9
1034	7.23	0.91	1.028	14.04	45	7.0
1037	7.23	0.91	1.028	13.88	45	6.9

Comment: 2.0 gal removed

Well ID: MW-9 Job No: 98-478-04

Date Sampled: 10/27/2003

Sampled by: BAC

Well Diameter: 4"

DTW: 9.74

DTB: 28.05

Estimated Pump Setting: 23"

Estimated Flow Rate: 150 ml/min

Sample Collection Time: 1220

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
1137	7.02	3.21	1.004	11.73	97	31.5
1140	6.98	1.57	0.991	12.20	75	14.5
1143	6.97	1.15	0.990	12.23	62	15.0
1147	6.97	1.18	0.991	12.06	53	12.1
1151	6.97	1.15	0.991	12.05	52	13.1
1155	6.97	1.06	0.990	12.26	50	13.1
1159	6.97	0.99	0.989	12.40	50	13.7
1202	6.97	0.94	0.988	12.54	50	11.9
1205	6.97	0.91	0.987	12.61	51	13.1
1208	6.97	0.80	0.984	13.01	52	10.9
1212	6.96	0.75	0.975	13.52	56	8.8
1215	6.97	0.74	0.972	13.10	56	8.3
1218	6.97	0.70	0.967	13.52	56	7.9
1231	7.08	1.27	0.876	13.48	122	5.8

Comment: 2.0 gal removed

Well ID: MW-10 Job No: 98-478-04

Date Sampled: 10/28/2003

Sampled by: BAC

Well Diameter: 4"

DTW: 5.36

DTB: 22.08

Estimated Pump Setting: 17'

Estimated Flow Rate: 180 ml/min

Sample Collection Time: 920

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
831	6.65	6.35	6.58	8.75	286	23.8
834	6.75	2.31	7.59	10.31	252	13.9
837	6.74	1.42	7.57	9.83	170	13.5
840	6.74	1.34	7.54	9.74	166	13.4
844	6.74	1.19	7.49	9.88	139	16.5
848	6.73	1.06	7.29	10.08	116	20.7
851	6.73	1.03	7.18	10.14	111	18.3
854	6.73	0.96	7.07	10.20	105	18.5
857	6.73	0.90	6.97	10.02	98	19.4
900	6.73	0.88	6.92	10.00	95	18.7
903	6.73	0.84	6.89	9.99	87	18.5
906	6.73	0.82	6.87	10.01	85	17.8
909	6.73	0.81	6.78	9.95	80	16.9
912	6.73	0.77	6.77	10.14	73	16.8
915	6.73	0.76	6.73	10.22	69	16.3
918	6.73	0.74	6.69	10.23	68	15.8
923	6.73	0.83	6.55	10.72	64	25

Comment: 2.5 gal removed

Well ID: MW-11 Job No: 98-478-04

Date Sampled: 10/27/2003

Sampled by: BAC

Well Diameter: 4"

DTW: 9.75

DTB: 26.2

Estimated Pump Setting: 21'

Estimated Flow Rate: 210 ml/min

Sample Collection Time: 915

Laboratory: Beech Grove, IN

Time	pH	Dissolved Oxygen	Specific Cond.	Temperature	O.R.P.	Turb.
		mg/l	µS/cm	°C	mV	NTU
834	7.04	3.73	1.088	10.58	287	49.3
837	7.08	2.21	1.105	11.31	236	9.1
840	7.10	1.52	1.108	11.26	200	6.5
843	7.11	1.36	1.109	10.61	167	6.7
846	7.10	1.28	1.110	10.90	138	5.4
849	7.10	1.13	1.110	10.97	109	5.3
852	7.09	1.08	1.111	11.06	101	5.0
855	7.09	0.96	1.111	11.09	82	4.9
858	7.09	0.90	1.112	11.13	71	4.9
901	7.09	0.84	1.114	11.19	57	4.1
904	7.08	0.83	1.114	11.14	50	4.0
907	7.08	0.77	1.115	11.15	45	3.9
910	7.08	0.76	1.115	11.16	43	3.6
913	7.06	0.74	1.116	11.17	41	3.1
917	7.04	0.87	1.117	12.04	34	6.2

Comment: 2.5 gal removed

ATTACHMENT 2

Baseline Human Health Risk Assessment for Refined Metals Corporation Facility Beech Grove, Indiana

Conducted as Part of the Phase I Corrective Measures Study

Prepared for
Refined Metals Corporation
3000 Montrose Ave
Reading, PA 19605-2751

Prepared by
Gradient Corporation
238 Main Street
Cambridge, MA 02142

June 18, 2004

Table of Contents

Page

1 Introduction

1.1 Site Description and History

The Refined Metals Corporation (RMC) facility is located at 3700 South Arlington Avenue in Beech Grove, Indiana. Secondary lead smelting and refining operations were conducted at this site from 1968 to the end of 1995.

The site occupies approximately 24 acres, of which approximately 10 acres represented the active manufacturing area (including paved areas and buildings). The remaining 14 acres includes grassed and wooded site areas. The site is bordered by Arlington Avenue to the east, a natural gas facility (Citizen's Gas) to the west, a railroad to the north, and Big Four Road to the south (Figure 1). The site is relatively flat with less than 10 feet of total relief. Natural site drainage is toward the north and east. The former manufacturing area is almost completely paved, and is characterized by nearly 80,000 square feet of structures consisting of the battery breaker, a wastewater treatment plant, material storage areas, a blast furnace, a dust furnace, a metals refining area, warehouse and offices.

The RMC facility was divided into two exposure areas for the purpose of this evaluation: the fenced facility area consisting of the plant buildings and surrounding paved areas; and the grassy areas to the north, east, and south of the paved facility area. The Citizen's Gas property to the west was evaluated as a separate exposure area.

1.2 Previous Investigations

On July 14, 1998, RMC entered into a Consent Decree with the United States Environmental Protection Agency (USEPA) and the Indiana Department of Environmental Management (IDEM). Under this Consent Decree, a RCRA Facility Investigation (RFI) was performed to evaluate and determine the nature and extent of releases and to collect information necessary to support human health and ecological risk assessments so that a Corrective Measures Study may be implemented. Pursuant to Section VI, Paragraph 42 of the Consent Decree (Compliance Requirements for Corrective Action), Advanced GeoServices Corp. (AGC) performed the RFI in accordance with an approved RFI work plan on behalf of RMC. The preparation and implementation of the RFI work plans were enacted in accordance with Exhibit B of the Consent Decree and the EPA's RCRA Facility Investigation Guidance Document (EPA 530/SW-89-031). The RFI was conducted in multiple phases. The results from the initial phase of sampling were presented in the Phase I RFI Report dated August 31, 2000. Based on the results of the Phase I RFI a Phase II RFI Work Plan was submitted to the EPA on December 20, 2000. In response to comments on the Phase II RFI Work Plan issued by the EPA on April 3, 2001, revisions to the Phase II RFI Work Plan were submitted to the EPA on June 27, 2001. The EPA approved the Phase II RFI Work Plan on July 13, 2001, the results of which were contained in the Phase II RFI Report dated November 18, 2002. Additional site sampling was conducted during a closure investigation to address three former RCRA-regulated solid waste managements units (SWMUs). The results of the SWMU closure investigation were presented by AGC in the Closure Investigation Report dated June 1, 2001.

1.3 Report Objectives and Organization

This report presents the results of the baseline human health risk assessment (HHRA) that was conducted to evaluate potential human health risks in each exposure area. The purpose of this evaluation is to determine whether these areas pose any significant health risks or if they require remediation to reduce risk to acceptable levels.

The remainder of this report is organized in the following sections. Section 2 discusses the data used in the risk assessment, and the constituents of potential concern. Section 3 discusses the potential receptors, exposure media, and exposure pathways for each exposure area. Section 4 presents the toxicity assessment. Section 5 presents the risk characterization. Section 6 presents soil lead cleanup levels. Section 7 presents the conclusions for all scenarios evaluated.

2 Constituents of Potential Concern

The results of the Phase I RFI indicated that lead and arsenic are the main contaminants of concern in soil, both onsite and offsite. Lead and arsenic were detected in soil samples from the site at concentrations above both residential and industrial risk-based concentrations (RBCs). The baseline risk assessment retained lead and arsenic as COPCs in soil.

3 Exposure Assessment

3.1 Potential Receptors and Exposure Pathways

The potential receptors, exposure media, exposure pathways, and exposure frequencies evaluated in each exposure area are presented in Table 1, and are discussed in more detail below.

Table 1
Receptors and Exposure Pathways

Exposure Area	Media	Soil Depth	Exposure Pathways	Receptors	Exposure Frequency (days/year)	Exposure Duration (years)
Plant Area	Subsurface soil	0-5 ft	Ingestion, Dermal Contact	Construction Worker	50	5
Plant Area	Subsurface soil	0-5 ft	Ingestion, Dermal Contact	Utility Worker	10	10
North, South, and East Grassy Areas	Surface soil	0-6"	Ingestion, Dermal Contact	Groundskeeper	50	25
				Adolescent Trespasser	25	5
				Future Site Worker	144	25
Off Site Natural Gas Facility	Surface soil	0-6"	Ingestion, Dermal Contact	Adult Worker (30 yr)	225	25

3.1.1 Facility Area

The plant buildings and surrounding paved areas occupy approximately the central third of the RMC property. The site is largely paved – the only exposed surface soil is limited to a strip along the western fence line. In this exposure area, we evaluated a utility worker and a construction worker who could be exposed to subsurface soil. Both the utility and construction worker are assumed to be exposed to subsurface soil at depths from 0 to 5 feet, *via* incidental ingestion and dermal contact. The utility worker is assumed to have an exposure frequency of 10 days/year and an exposure duration of 10 years. The construction worker is assumed to have an exposure frequency of 50 days/year for 5 years.

3.1.2 Grassy Areas North, South, and East of Main Facility

The grassy and wooded areas located north, south, and east of the main facility encompass approximately the northern and southern thirds of the RMC property (Figure 1). The receptors evaluated in both of these areas include an adolescent trespasser and an adult groundskeeper under current use, and a future site worker. These receptors are assumed to be exposed to surface soil *via* incidental ingestion and dermal contact. The adolescent trespasser (age 13-18 years) is assumed to have an exposure frequency of 25 days/year and an exposure duration of 5 years. The groundskeeper is assumed to have an exposure frequency of 50 days/year and an exposure duration of 25 years. A future site worker is assumed to spend most of his time in the plant and surrounding paved areas. However, he may have occasion to visit the grassy/wooded areas for a walk or to eat lunch at a picnic table. The future site worker is assumed to have an exposure frequency in these areas of 4 days/week for 36 weeks/year or 144 days/year, and an exposure duration of 25 years.

3.1.3 Offsite Natural Gas Facility

At the offsite natural gas facility, an adult commercial worker was evaluated. The worker is assumed to be exposed to surface soil *via* incidental ingestion and dermal contact. The worker is assumed to have an exposure frequency in these areas of 5 days/week for 45 weeks/year, or 225 days/year, and an exposure duration of 25 years.

3.2 Exposure Point Concentrations

In a risk assessment, an Exposure Point Concentration (EPC) represents the concentration of a chemical in an environmental medium to which an individual is exposed. The calculation of EPCs is described below. The EPCs used in this risk evaluation are presented in Table 2.

Table 2
Exposure Point Concentrations

			Arsenic		Lead	
Exposure Area	**Medium**	**Depth**	**EPC mg/kg**	**Basis 95%UCL**	**EPC mg/kg**	**Basis**
Plant Area	Subsurface Soil	0-5 ft	123	NP, bootstrap	20,266	arithmetic mean
Grassy Area	Surface Soil	0-6 in	312	NP, bootstrap	15,916	arithmetic mean
Offsite Natural Gas Facility	Surface Soil	0-6 in	28.5	LN, H-UCL	1,311	arithmetic mean

NP Nonparametric
LN Lognormal

For arsenic, the EPCs were the 95% upper confidence level on the mean (95UCL) concentration. The 95UCL is used instead of the mean or arithmetic average because it is not possible to know the true mean (USEPA, 1992b). The 95UCL is defined as a value that ..."equals or exceeds the true mean 95% of the time" (USEPA, 1992b). As sampling data become more representative of actual site conditions, uncertainties decrease, and the 95UCL approaches the true mean. The 95UCL values were calculated with ProUCL© according to USEPA guidance (USEPA, 2002).

To evaluate lead risks, the arithmetic mean soil lead concentration within the exposure area was used as the EPC to be consistent with USEPA guidance (USEPA, 1994; USEPA, 1996)

3.3 Quantification of Exposure

This section discusses the basis for calculating human intake levels resulting from exposures to COPCs other than lead (in this case arsenic), and describes each input parameter. Human intake levels for lead are discussed in Section 5. Exposure estimates represent the daily dose of a chemical taken into the body, averaged over the appropriate exposure period, expressed in the units of milligram (mg) of chemical per kilogram (kg) of human body weight per day. The primary source for the exposure equations used in the HHRA is the USEPA's "*Risk Assessment Guidance for Superfund* (RAGS)" (USEPA, 1989).[1] The generalized equation for calculating chemical intakes is shown below:

$$I = \frac{EPC \times CR \times EF \times ED}{BW \times AT}$$

where:

I	=	Intake, the amount of chemical at the exchange boundary (mg/kg body weight-day),
EPC	=	Exposure Point Concentration, the chemical concentration contacted over the exposure period at the exposure point (*e.g.*, mg/kg in soil),
CR	=	Contact Rate, the amount of contaminated medium contacted per unit time or event (*e.g.*, soil ingestion rate (mg/day)),
EF	=	Exposure Frequency, describes how often exposure occurs (days/year),
ED	=	Exposure Duration, describes how long exposure occurs (yr),
BW	=	Body Weight, the average body weight over the exposure period (kg), and
AT	=	Averaging Time, period over which exposure is averaged (days).

Exposure factors (*e.g.*, contact rate, exposure frequency, exposure duration, body weight) describe a receptor's exposure for a given exposure scenario. The values used for each exposure factor are summarized in Table 3 and discussed in detail below. The exposure factor input values are consistent with current USEPA guidance. Where appropriate, exposure parameters were based on site-specific considerations and professional judgment.

[1] Note that this approach is not used to evaluate lead. Consistent with USEPA guidance, lead exposure is evaluated using a child or adult lead model to estimate blood lead levels.

Table 3
Summary of Exposure Factor Input Values

Exposure Area Receptor	Onsite Construction Worker	Onsite Utility Worker	Grassy Area Site Worker	Grassy Area Grounds-keeper	Grassy Area Adolescent Trespasser	Offsite Gas Facility Worker
Exposure Pathway/Exposure Factor						
Ingestion of Soil						
Ingestion Rate (mg/kg)	100	100	50	50	50	50
Exposure Duration (yr)	5	10	25	25	5	25
Exposure Frequency (days/yr)	50	10	144	50	25	225
Body Weight (kg)	70	70	70	70	58	70
Bioavailability (arsenic)	0.8	0.8	0.8	0.8	0.8	0.8
Conversion Factor (kg/mg)	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001
Fraction from Contaminated Source	1	1	1	1	1	1
Averaging Time (days) – Cancer	25550	25550	25550	25550	25550	25550
Averaging Time (days) - Non Cancer	365	3650	9125	9125	1825	9125
Dermal Contact with Soil						
Dermal Absorption Factor (arsenic)	0.03	0.03	0.03	0.03	0.03	0.03
Soil Adherence Factor (mg/cm^2)	0.2	0.2	0.07	0.2	0.07	0.2
Surface Area (cm^2/d)	3300	3300	3300	3300	4270	3300
Exposure Duration (years)	5	10	25	25	5	25
Exposure Frequency (days/yr)	50	10	144	50	25	225
Body Weight (kg)	70	70	70	70	58	70
Conversion Factor (kg/mg)	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001
Fraction from Contaminated Source	1	1	1	1	1	1
Averaging Time (days) - Cancer	25550	25550	25550	25550	25550	25550
Averaging Time (days) - Non Cancer	365	3650	9125	9125	1825	9125

3.3.1 Ingestion of Soil

For the soil ingestion pathway intake is calculated as:

$$Intake\left(\frac{mg}{kg \cdot day}\right) = \frac{C_{soil}\left(\frac{mg}{kg}\right) \times B \times IR_{soil}\left(\frac{mg}{day}\right) \times FS \times EF\left(\frac{days}{yr}\right) \times ED(yrs) \times 10^{-6}\,\frac{kg}{mg}}{BW(kg) \times AT(days)}$$

where:

C_{soil}	=	Concentration of the chemical in soil (mg/kg)
B	=	Relative Bioavailability, the relative oral absorption fraction (unitless)
IR_{soil}	=	Soil Ingestion Rate (mg/day)
FS	=	Fraction of Soil from the site (unitless)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)

Gradient used conservative USEPA-recommended values for each of the input parameters. The basis for each value used is detailed below.

Soil Concentrations (C_{soil}). As summarized in Section 3.2, the 95UCL was used as the EPC.

Relative Bioavailability (B). To accurately quantify potential exposures from ingestion of soil, it is important to consider the amount of a chemical that is solubilized in gastrointestinal fluids and absorbed across the gastrointestinal tract into the bloodstream. A chemical present in soil may be absorbed less completely than the same dose of the chemical administered in toxicity studies used to evaluate safe dose levels. A relative bioavailability estimate for a specific compound represents the absorption fraction from soil (the exposure route of concern) relative to the absorption fraction from food or water (in most toxicity studies, chemical doses are administered in food or water).

It is widely recognized that bioavailability of many metals and organics from soil tends to be considerably lower than bioavailability from food or water. USEPA guidance recognizes the need to make adjustments for the reduced bioavailability of compounds in soil. Specifically, in Appendix A of USEPA's Risk Assessment Guidance for Superfund (USEPA, 1989, pg. A-3), USEPA notes:

> "If the medium of exposure in the site exposure assessment differs from the medium of exposure assumed by the toxicity value (*e.g.*, RfD values usually are based on or have been adjusted to reflect exposure *via* drinking water, while the site medium of concern may be soil), an absorption adjustment may, on occasion, be appropriate. For example, a substance might be more completely absorbed following exposure to contaminated drinking water than following exposure to contaminated food or soil (*e.g.*, if the substance does not desorb from soil in the gastrointestinal tract)."

USEPA Region 10 risk assessment guidance provides default values for the bioavailability of arsenic in soil. Region 10 notes that if the site is a smelter site and its appears likely that the arsenic exists primarily as finely-grained oxides from smelter stack emissions, then a value of 80% relative bioavailability may be assumed. Region 10 notes that this value is supported by a conservative interpretation of the scientific literature (USEPA Region 10, 1997). A relative bioavailability of 80% was used for arsenic in this risk assessment.

For lead, the USEPA recommends an oral absorption factor for adults of 0.12 for ingestion of lead in soil, based on 20% absorption of soluble lead, and a relative bioavailability of 60% for lead in soil (*i.e.*, $0.12 = 0.2 \times 0.6$) (USEPA, 1996). Gradient used the recommended USEPA absorption factor of 0.12 to evaluate ingestion of lead contaminated soil for adult receptors.

Soil Ingestion Rate (IR_{soil}). A daily soil and dust ingestion rate of 50 mg/day was used for the adolescent trespasser and the following adult receptors: site worker, groundskeeper, and offsite gas facility worker. USEPA considers this value to be a reasonable central estimate of adult soil ingestion and notes that although this value is highly uncertain, "a recommendation for an upper percentile value would be inappropriate" (USEPA, 1997a). A daily soil and dust ingestion rate of 100 mg/day was used for the onsite construction worker and the onsite utility worker, as these receptors are assumed to have more intensive contact with soil than the other adult receptors.

Fraction of Soil From the Site (FS). For all receptors, it was assumed that 100% of the individual's daily soil exposure occurred at the site. This assumption is likely to overestimate exposure to contaminated soil for workers and trespassers because workers are assumed to be at the site for only 8 hours per day, and trespassers are likely present less than 2 hours per visit.

Exposure Frequency (EF) and Exposure Duration (ED). The exposure frequency and duration used for each receptor are discussed in Section 3.1.1 to 3.1.3. For the site worker, groundskeeper, and offsite gas worker, the exposure duration is 25 years. This is the 95^{th} percentile duration that an individual stays at any one workplace (USEPA, 1991). Hence, this assumption overestimates exposures for most workers, because the median occupational tenure of the working population has been estimated to be 6.6 years (USEPA, 1997a).

Body Weight (BW). Although the average U.S. adult body weight in the current Exposure Factors Handbook (USEPA, 1997a) is 71.8 kg, a mean adult body weight of 70 kg (USEPA, 1991) was used in the HHRA, so that the body weight would be consistent with that used in deriving the toxicity factors. Average body weight for the adolescent trespasser (13-18 year old) was calculated from data in USEPA's Exposure Factors Handbook and used in the HHRA (USEPA, 1997a).

Averaging Time (AT). For non-cancer risks, the averaging time was equal to the exposure duration multiplied by 365 days/year. For cancer risks, exposures were averaged over a 70-year average lifetime (USEPA, 1991). Although the current life expectancy for men and women in the U.S. is 76.7 years (USEPA, 1997a), a value of 70 years (25,550 days) was used to be consistent with the value used in deriving the toxicity factors.

3.3.2 Dermal Contact with Surface Soil

For dermal exposure to contaminants in soil, a dermal intake (the amount absorbed into the body) is calculated as (USEPA, 1999):

$$Intake\left(\frac{mg}{kg \cdot day}\right) = \frac{C_{soil}\left(\frac{mg}{kg}\right) \times DA \times AF\left(\frac{mg}{cm^2}\right) \times SA\left(\frac{cm^2}{event}\right) \times EF\left(\frac{events}{yr}\right) \times ED(yrs) \times 10^{-6}\,\frac{kg}{mg}}{BW(kg) \times AT(days)}$$

where:

C_{soil}	=	Concentration of the chemical in soil (mg/kg),
DA	=	Dermal Absorption factor (unitless)
AF	=	Soil/skin Adherence Factor (mg/cm^2),
SA	=	Skin surface Area exposed (cm^2/exposure event),
EF	=	Exposure Frequency (exposure events/year),
ED	=	Exposure Duration (years),
BW	=	Body Weight (kg), and
AT	=	Averaging Time (days).

There are three parameters in this equation that are different from those discussed in the previous section (Section 3.3.1). Only those parameters unique to the dermal exposure equation, dermal absorption fraction (DA), the soil adherence factor (AF), and the skin surface area (SA), are discussed in this section.

Note that since absorbed doses are used for the dermal pathway, the toxicity criteria are adjusted so they apply to absorbed doses. This adjustment is discussed in more detail in the toxicity section (Section 4).

Dermal Absorption Fraction (DA). The dermal absorption fraction represents the amount of a chemical in contact with skin that is absorbed through the skin and into the bloodstream. The dermal absorption fraction for arsenic (0.03) was obtained from USEPA's dermal risk assessment guidance (USEPA, 1999; Table 3.4).

Soil to Skin Adherence Factor (AF). The adherence factor relates the amount of soil that adheres to the skin per unit of surface area (USEPA, 1999). Adherence factors vary depending on the properties of the soil, the part of the body, and the type of activity. Gradient used the 50th percentile weighted adherence factors from USEPA's dermal risk assessment guidance (USEPA, 2001). The AF for utility workers (0.2 mg/cm^2) was used for the construction worker, utility worker, groundskeeper, and offsite gas facility worker. EPA's recommended AF for the residential adult (0.07 mg/cm^2) was used for the future site worker and the adolescent trespasser.

Skin Surface Area Exposed (SA). This parameter reflects the amount of skin that is available for exposure to soil. The skin surface areas used in the HHRA were 3300 cm^2 for the construction worker, utility worker, site worker, groundskeeper, and offsite gas facility worker, based on the face, hands, and forearms; and 4270 cm^2 for the trespasser, based on the face, hands, forearms, and lower legs. Surface areas were calculated using USEPA's Exposure Factors Handbook (USEPA, 1997).

4 Toxicity Assessment

4.1 Overview of Toxicity Values

Gradient has evaluated potential cancer and non-cancer risks from exposure to arsenic using dose-response relationships for carcinogenicity (oral Cancer Slope Factors) and systemic toxicity (oral Reference Doses). Lead toxicity is discussed separately in Section 4.2. The primary source of toxicity values was the USEPA's Integrated Risk Information System (IRIS) (USEPA, 2004). Toxicity values in IRIS undergo a rigorous peer review process and are generally considered to be of high quality. The toxicity factors used in the HHRA are summarized in Table 4-1.

Table 4
Toxicity Factors

Compound	RfD_{oral} (mg/kg-day)	Critical Effect	RfD Source	Uncertainty Factor	Oral Absorption	RfD_{dermal} (mg/kg-day)	CSF_{oral} (mg/kg-day)	CSF_{dermal} (mg/kg-day)
Arsenic	0.0003	Hyperpigmentation, keratosis and possible vascular complications	IRIS	3	95%	0.0003	1.5	1.5

4.1.1 Oral Reference Doses (RfD_{oral})

An RfD is an estimate of daily exposure that a sensitive population can experience over a lifetime with a negligible risk of systemic health effects. The USEPA derives RfDs by first identifying the highest dose level that does not cause observable adverse effects (*i.e.*, the No Observed-Adverse Effect Level, or NOAEL; USEPA, 1993). If a NOAEL was not identified, a Lowest Observed Adverse Effect-Level, or LOAEL, may be used. This dose level is then divided by uncertainty factors to calculate an RfD. An uncertainty factor of 100 is often used, to account for interspecies differences (if animal studies were used) and sensitive human subpopulations (*e.g.*, children and the elderly; USEPA, 1993). Additional uncertainty factors may be used, depending on the quality of the toxicological data.

4.1.2 Oral Cancer Slope Factors (CSF_{oral})

The CSF is an upper bound estimate of carcinogenic potency used to calculate risk from exposure to carcinogens, by relating estimates of lifetime average chemical intake to the incremental risk of an individual developing cancer over their lifetime (USEPA, 1992c). The CSFs recommended by the USEPA are conservative upper bound estimates, which means that the USEPA is reasonably confident that the "true" cancer risk does not exceed the estimated risk calculated using the CSF, and may be as low as zero.

4.1.3 Dermal Reference Doses (RfD_{dermal})

There are no USEPA-derived toxicity values based specifically on toxicity studies involving dermal exposures. In the absence of dermal-specific RfDs, oral toxicity factors are used, assuming that once a chemical is absorbed into the blood stream, the health effects are similar regardless of whether the route of exposure is oral or dermal. However, since oral toxicity criteria are based on the amount of a chemical *administered* per unit time and body weight (chemical intake), they need to be adjusted to be applicable to *absorbed* doses (dermal exposures are expressed as absorbed intake levels) (USEPA, 1989; 1992a; 1999).

Since most RfDs are based on studies where a chemical is administered in food or water, this adjustment is made using the oral absorption efficiency for that chemical. If oral absorption is very high (almost 100%), then the absorbed dose is virtually the same as the administered dose, and no adjustment of the toxicity factor is necessary. If oral absorption is very low (*e.g.*, 5%), the absorbed dose is much smaller than the administered dose, and an adjustment of the toxicity criteria is necessary. For any given chemical, the USEPA recommends adjusting the oral toxicity factor for use in evaluating dermal risks only when the oral absorption for that chemical is less than 50%, to "obviate the need to make comparatively small adjustments in the toxicity value that would otherwise impart on the process a level of accuracy that is not supported by the scientific literature" (USEPA, 1999).

For non-cancer effects, this adjustment is made by multiplying the oral RfD (for applied doses) by the oral absorption efficiency (*i.e.*, $RfD_{oral} \times Abs_{oral} = RfD_{dermal}$). For arsenic, the oral absorption efficiency is 95%, therefore no adjustment is necessary and the RfD_{dermal} is the same as the RfD_{oral} (Table 4).

4.1.4 Dermal Cancer Slope Factors (CSF_{dermal})

There are no USEPA-derived toxicity values specifically for cancer studies involving dermal exposures. In the absence of dermal-specific CSFs, oral CSFs are used, assuming that once a chemical is absorbed into the blood stream, the carcinogenic effect is similar regardless of whether the route of exposure is oral or dermal. However, since oral CSFs are based on the amount of a chemical *administered* per unit time and body weight (chemical intake), they need to be adjusted to be applicable to *absorbed* doses (dermal exposures are expressed as absorbed intake levels) (USEPA, 1989; 1992a; 1999). For any given chemical, the USEPA recommends adjusting the oral CSF for use in evaluating dermal risks only when the oral absorption for that chemical is less than 50%, to "obviate the need to make comparatively small adjustments in the toxicity value that would otherwise impart on the process a level of accuracy that is not supported by the scientific literature" (USEPA, 1999).

For cancer, this adjustment is made by dividing the oral CSF (for applied doses) by the oral absorption efficiency (*i.e.*, $CSF_{oral} / Abs_{oral} = CSF_{dermal}$), if the oral absorption efficiency is less than 50%. For arsenic, this value is 95%, therefore the CSF_{dermal} is the same as the CSF_{oral} (Table 4).

4.2 Toxicity Values for COPCs

The basis of the arsenic toxicity values is described in this section and summarized in Table 4. Lead toxicity is also discussed in this section because of the unique way exposure and risk are evaluated for this metal.

4.2.1 Arsenic

The toxicity criteria for arsenic were obtained from the USEPA IRIS database (USEPA, 2000). The derivation of each of these values, and the scientific uncertainties concerning arsenic toxicity, are discussed below.

4.2.1.1 Arsenic RfD_{oral}

USEPA cites an RfD_{oral} for arsenic of 0.0003 mg/kg-day (USEPA, 2000). The arsenic RfD_{oral} is based on increased incidence of hyperpigmentation, keratosis and possible vascular complications in a study of a large population (over 40,000 people) in Taiwan with chronic exposure to arsenic in drinking water and food (Tseng, 1977; Tseng *et al.*, 1968). The USEPA characterized a NOAEL of 0.0008 mg/kg/day for skin lesions in the Tseng study, based on the drinking water concentration in the NOAEL group (0.009 mg/L), an assumed drinking water ingestion rate of 4.5 L, daily arsenic intake from sweet potatoes and rice of 0.002 mg/day, and an average Taiwanese body weight of 55 kg ((0.009 mg/L × 4.5 L/day) + 0.002 mg/day / 55 kg) (Abernathy *et al.*, 1989). An uncertainty factor of 3 (based on the lack of reproductive toxicity data and uncertainty regarding toxicity in sensitive individuals) was applied to the NOAEL to derive an RfD of 0.0003 mg/kg/day (0.0008/3). Overall, the USEPA has "medium" confidence in the study, "medium" confidence in the database (due to poor characterization of the dose levels in the Tseng and other supporting studies), and "medium" confidence in the RfD_{oral} for arsenic. It is noted in the arsenic IRIS file that a clear consensus does not exist among USEPA scientists regarding arsenic systemic toxicity (USEPA, 2000).

4.2.1.2 Arsenic CSF_{oral}

USEPA concluded that arsenic is a "human carcinogen," a weight-of-evidence classification for carcinogenicity of "A" (USEPA, 2000). This classification is based on sufficient evidence of carcinogenicity in human populations. Lung cancer has been associated with inhalation of arsenic, and skin, bladder, and possibly other internal cancers have been associated with ingestion of arsenic in drinking water.

In IRIS, the USEPA recommends a CSF_{oral} value for arsenic of 1.5 $(mg/kg/day)^{-1}$ (USEPA, 2000). This value is based on skin cancer incidence rates in the same Taiwanese study used as the basis for the RfD_{oral} value (Tseng, 1977; Tseng *et al.*, 1968). This value was calculated using a multistage model, assuming a drinking water ingestion rate of 3.5 L/day for Taiwanese males and 2 L/day for Taiwanese females, an average Taiwanese body weight of 55 kg, and an average U.S. body weight of 70 kg.

There is currently considerable debate among the scientific community regarding the arsenic CSF_{oral}. Many researchers believe that the current value of 1.5 $(mg/kg/day)^{-1}$ may overestimate cancer risks for U.S. populations (see, for example, Slayton *et al.*, 1996; Chappell *et al.*, 1997).

4.2.1.3 Arsenic RfD_{derm} and CSF_{derm}

In general, for dermal exposures (expressed as absorbed intake levels), the RfD_{oral} and CSF_{oral} are adjusted to be applicable to absorbed doses (USEPA, 1989; 1992a). This adjustment is made assuming that once a chemical is absorbed into the blood stream, the health effects are similar regardless of whether the route of exposure is oral or dermal. However, since oral absorption for arsenic is about 95% (USEPA, 1999), and the USEPA recommends adjusting dermal toxicity factors only when oral absorption is less than 50%, no adjustment was made for arsenic.

4.2.2 Lead

The ingestion of lead at certain levels can result in significant health effects, particularly among children. Epidemiological investigators have reported a correlation between blood lead levels (BLLs) in children and adverse health effects. High levels of lead intake can cause kidney damage, convulsions, coma, and even death (ATSDR, 1999). However, health effects resulting from lower levels of lead exposure are more common, and are related to cognitive and neuro-behavior impacts, including the impairment of intellectual performance.

The USEPA has not established any toxicity criteria (RfD, CSF) for lead (USEPA, 2004); instead, lead risks are evaluated by modeling blood lead levels. Lead risks in adults were evaluated using USEPA's Adult Lead Model (USEPA, 2003). This model is discussed in more detail in Section 5.4.

The USEPA has assigned lead a Weight-of-Evidence Classification for human carcinogenicity of "B2", a "probable human carcinogen," based on sufficient animal evidence but inadequate human evidence (USEPA, 2004). Even though the weight of evidence for lead carcinogenicity is B2, the USEPA does not evaluate lead cancer risk using a CSF, having concluded that neurological effects in young children are the most relevant endpoint.

5 Risk Characterization

In this section, cancer and non-cancer health risks are estimated by combining the information from Sections 2 through 4. The calculations used to estimate cancer and noncancer risks are presented in Sections 5.1 and 5.2, respectively. Section 5.3 discusses the calculated cancer and noncancer risks for each exposure area. Section 5.4 presents the lead risks by exposure area. Section 5.5 provides a qualitative discussion of the most significant sources of uncertainty in the risk estimates.

5.1 Calculation of Cancer Risks

Excess lifetime cancer risks are characterized as the incremental probability that an individual will develop cancer during his or her lifetime due to chemical exposure to constituents at the site under the specific exposure scenarios evaluated. The term "incremental" implies the risk above the background cancer risk experienced by all individuals in the course of daily life. According to Greenlee *et al.* (2001), the lifetime probability of developing cancer (*i.e.*, background cancer risk) is approximately 0.435 in men, and 0.383 in women. Cancer risks are expressed as a unitless probability (*e.g.*, one in a million, or 10^{-6}) of an individual developing cancer over a lifetime, above background risk, as a result of exposure to impacted environmental media at a site.

Excess (incremental) cancer risks for all of the exposure pathways (oral, dermal, and inhalation) are calculated using intake estimates (lifetime average daily doses, calculated in Section 3 as part of the exposure assessment) and CSFs (summarized as part of the toxicity assessment in Section 4) as follows (USEPA, 1989):

$$CancerRisk = Intake\left(\frac{mg}{kg \cdot day}\right) \times CSF\left(\frac{mg}{kg \cdot day}\right)^{-1}$$

For ingestion pathways, oral intake estimates (expressed as applied or administered dose levels) are multiplied by the oral CSF (applicable to applied/administered doses). Similarly, for inhalation pathways, inhalation intake estimates (also expressed as applied or administered dose levels) are multiplied by the inhalation CSF (applicable to applied/administered doses). For dermal exposures, dermal intake estimates (expressed as an absorbed dose level) are multiplied by an adjusted oral CSF (adjusted to apply to absorbed doses) (USEPA, 1999). The total cancer risk for each receptor is the sum of the risks across all of the exposure pathways.

5.2 Calculation of Noncancer Risks

Risks from non-carcinogenic health effects are expressed as hazard quotients rather than as probabilities. A hazard quotient compares the calculated exposure (average daily doses, calculated as part of the exposure assessment in Section 3) to acceptable reference exposures derived by the USEPA (*e.g.*, RfDs, summarized as part of the toxicity assessment in Section 4). The hazard quotient is calculated from the RfD as follows (USEPA, 1989):

$$HazardQuotient = \frac{Intake\left(\frac{mg}{kg \cdot day}\right)}{RfD\left(\frac{mg}{kg \cdot day}\right)}$$

For the ingestion exposure route an oral intake estimate (expressed as applied or administered dose) is divided by the oral RfD (applicable to applied/administered dose). Similarly, for the inhalation exposure route an inhalation intake estimate (also expressed as applied or administered dose) is divided by the inhalation RfD (applicable to applied/administered dose). For dermal exposure, a dermal intake estimate (expressed as an absorbed dose) is divided by an adjusted oral RfD (adjusted to apply to absorbed dose).

Hazard indices are calculated for each receptor and exposure pathway, according to USEPA guidance (1989). A hazard index greater than 1.0 is considered to represent a significant health risk. Because a hazard quotient is simply a ratio of site exposures to reference exposure levels (*e.g.*, RfDs, RfCs, *etc.*), hazard indices do not represent the probability that an adverse health effect could occur. They simply indicate whether an estimated exposure for an individual presents a significant noncancer health risk, based on the USEPA's recommended reference dose.

5.3 Estimated Cancer and Noncancer Risks

The estimated cancer and noncancer risks for arsenic are discussed below by exposure area. Lead risks are discussed separately in Section 5.4. Cancer risks are summarized in Table 5. The total cancer risk for each receptor is the sum of the risks over all exposure routes and all exposure periods. Noncancer risks are summarized in Table 5. The total noncancer risk for each receptor is the sum of the risks over all exposure routes. The detailed risk calculation tables in Appendix A present the arsenic risks calculated for each receptor and exposure pathway. The percent contribution of each exposure pathway to the total risk is also shown.

5.3.1 Main Facility Area

In the main facility area onsite, we evaluated a construction worker and a utility worker for exposure to arsenic in subsurface soil *via* incidental ingestion and dermal contact.

The total excess lifetime cancer risk is 3×10^{-6} for the construction worker, and 1×10^{-6} for the utility worker. These risk estimates are within USEPA's target risk range of 1×10^{-6} to 1×10^{-4}, indicating that exposure to arsenic in subsurface soil in the main facility area does not present a significant cancer risk for the construction or utility worker.

The total hazard index (HI) is 0.1 for the construction worker, and 0.02 for the utility worker. These values are well below a HI of 1.0, therefore, exposure to arsenic in subsurface soil in the main facility area does not present a significant noncancer risk for the construction or utility worker.

5.3.2 Grassy Areas

In the grassy areas located north, south, and east of the main facility, we evaluated a future site worker, a groundskeeper, and an adolescent trespasser, for exposure to arsenic in surface soil *via* incidental ingestion and dermal contact.

The total excess lifetime cancer risks are 4×10^{-5} for the future site worker, 2×10^{-5} for the groundskeeper, and 2×10^{-6} for the adolescent trespasser. These risk estimates are within USEPA's target risk range of 1×10^{-6} to 1×10^{-4}, indicating that exposure to arsenic in surface soil in the grassy area does not present a significant cancer risk for these receptors.

The total hazard index (HI) is 0.3 for the future site worker, and 0.1 for the groundskeeper and adolescent trespasser. These values are well below a HI of 1.0, therefore, exposure to arsenic in surface soil in the grassy area around the facility does not present a significant noncancer risk for these receptors.

5.3.3 Offsite Natural Gas Facility

At the off-site natural gas facility to the west of the RMC property, we evaluated a facility worker exposed to arsenic in surface soil *via* ingestion and dermal contact.

The total excess lifetime cancer risk is 8×10^{-6} for the gas facility worker. This risk estimate is within USEPA's target risk range of 1×10^{-6} to 1×10^{-4}, indicating that exposure to arsenic in surface soil at the natural gas facility area does not present a significant cancer risk for the worker.

The total hazard index (HI) is 0.1 for the gas facility worker. This value is well below a HI of 1.0, therefore, exposure to arsenic in surface soil at the gas facility does not present a significant noncancer risk for the worker.

Table 5
Summary of Cancer and Noncancer Risks

Exposure Area	Medium	Receptor	Total Excess Lifetime Cancer Risk	Total Hazard Index
Main Plant Area	Subsurface soil	Construction Worker	3E-06	0.1
		Utility Worker	1E-06	0.02
Grassy Areas	Surface soil	Groundskeeper	2E-05	0.1
		Adolescent Trespasser	2E-06	0.1
		Future Site Worker	4E-05	0.3
Off Site Natural Gas Facility	Surface soil	Adult Worker	8E-06	0.1

5.4 Lead Risk Assessment

5.4.1 Adult Lead Model

Blood lead levels (BLLs) in adolescents and adults are assessed using USEPA's Adult Lead Model (ALM) (USEPA, 1996). USEPA's Adult Blood Lead Model predicts a median BLL estimate for an adult as a function of the baseline BLL plus an increment that is attributable to exposure to site soil. This increment is a function of the biokinetic slope factor, the concentration of lead in soil, the soil ingestion rate, the fraction of lead in soil that is absorbed, and the exposure frequency. EPA has selected a target BLL for an adult female, in order to protect a developing fetus such that no more than 5% of fetuses would be expected to have BLLs exceeding 10 µg/dL.

The basic form of the equation for the ALM is as follows:

$$BLL_{adult} = PbB + \frac{(EF \times AF \times PbS \times IR \times BKSF)}{AT}$$

The input values used in the model are summarized in Table 6 and described below. First, an average baseline lead concentration in blood (PbB_{base}) for adults is identified to account for continuing exposure to background levels of lead in food, soil, and dust, and pre-existing body burdens due to prior lead exposures. Baseline BLLs were obtained from the most recent National Health and Nutrition Examination Survey, from 1999-2000 (NHANES 2000) (U.S. Public Health Service, 2004). For adults we used the geometric mean (GM) and geometric standard deviation (GSD) BLLs for women of childbearing age (age 20-49). For the adolescent trespasser, we used the GM and GSD BLLs for males and females combined, for 13-18 year olds. To this baseline, the model adds the incremental increase in blood lead due to the lead source of interest (in this case, exposure to lead *via* ingestion of soil and dust).

The concentration of lead in soil (PbS) is the mean lead concentration in each exposure area. Lead uptake is calculated by multiplying the concentration of lead in soil by the soil/dust ingestion rate (IR) and the absorption fraction (AF) for lead in soil and dust. The AF is the amount of lead that is absorbed into the bloodstream from the gastrointestinal tract. The exposure frequency (EF) varies by receptor and exposure area. The EFs used for each receptor are presented in Table 3. The averaging time (AT) for chronic exposure to lead in soil is assumed to be one year (*i.e.*, 365 days). The biokinetic slope factor (BKSF) relates the incremental lead uptake into the body to an incremental increase in blood lead level in adults. USEPA's default value of 0.4 was used for the BKSF.

Table 6
Adult Lead Model Input Values

Term	Definition	Value
PbB_0	Geomean baseline BLL (μg/dL) for Adult females (age 20-49 yr)	1.2
GSD	Geometric standard deviation for Adult females	1.8
PbB_0	Geomean baseline BLL (μg/dL) for 13-18 yr old males and females	1.1
GSD	Geometric standard deviation for 13-18 yr old males and females	1.8
EF	Exposure Frequency (*i.e.*, number of days during the averaging time an individual is exposed to the lead source being evaluated (days))	Receptor-specific
AT	Averaging Time (days)	365
PbS	Soil/dust lead concentration (μg/g)	Area-Specific
IR	Soil/dust Ingestion Rate (g/day)	Receptor-specific 0.05 or 0.10
AF	Fraction of ingested lead absorbed into the blood stream (dimensionless)	0.12
BKSF	Biokinetic Slope Factor (change in blood lead per μg change in daily lead uptake) (μg/dL per μg/day)	0.4

Total BLLs for adults are predicted by adding the estimated incremental increase in blood lead to the average baseline BLL. A geometric standard deviation (GSD) appropriate for adults is used to estimate the probable range of BLLs around the predicted geometric mean adult BLL from the model. For this evaluation, we used the actual GSDs for the BLLs obtained from the NHANES-2000 database.

BLLs estimated using the ALM are evaluated based on a comparison to the USEPA risk management criterion for lead. Specifically, the health protection goal of the USEPA Office of Solid Waste and Emergency Response is to "limit exposure to soil lead levels such that a typical (or hypothetical) child or group of similarly exposed children would have an estimated risk of no more than 5% of exceeding a blood lead of 10 μg/dL" (USEPA, 1998a). The Centers for Disease Control (CDC) recommend that "the goal of all lead poisoning prevention activities should be to reduce children's BLLs below 10 μg/dL" (CDC, 1991). Based on a goal of keeping the BLL in children at or below 10 μg/dL, the BLL for women of child-bearing age should not exceed 11.1 μg/dL, because the fetal BLL is approximately 90% of the maternal BLL (*i.e.*, 90% of 11.1 μg/dL is 10 μg/dL). A BLL goal of 10 μg/dL was used for the adolescent trespasser.

The adult lead modeling results for all receptors, along with the input values, the predicted BLLs, and the probability of exceeding the target BLL, are presented in Table 7. The adult lead modeling results are discussed below by exposure area. The dermal exposure route for lead in soil was not evaluated because this exposure route is typically insignificant when compared to ingestion. The ALM makes no provision for assessing dermal exposures.

Table 7
Summary of Lead Risks and Cleanup Goals

Exposure Variable	Description of Exposure Variable	Units	Construction Worker	Utility Worker	Grounds-keeper	Trespasser	Worker	Worker
		Soil Exposure Depth	0-5 ft	0-5 ft	0-6"	0-6"	0-6"	0-6"
			Values for Non-Residential Exposure Scenario					
			Onsite		Grassy Area			Offsite Gas Facility
PbS	Soil lead concentration	ug/g or ppm	**20,266**	20,266	**15,916**	15,916	**15,916**	1311
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9	0.9	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4	0.4	0.4	0.4	0.4
GSD_i	Geometric standard deviation PbB	--	1.8	1.8	1.8	1.8	1.8	1.8
PbB_0	Baseline PbB	ug/dL	1.2	1.2	1.2	1.1	1.2	1.2
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.100	0.100	0.050	0.050	0.050	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--	--	--	--	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--	--	--	--	--
K_{SD}	Mass fraction of soil in dust	--	--	--	--	--	--	--
$AF_{S,D}$	Absorption fraction (same for soil and dust)	--	0.12	0.12	0.12	0.12	0.12	0.12
$EF_{S,D}$	Exposure frequency (same for soil and dust)	days/yr	50	10	50	25	144	225
$AT_{S,D}$	Averaging time (same for soil and dust)	days/yr	365	365	365	365	365	365
PbB_{adult}	PbB of adult worker, geometric mean	ug/dL	15	3.9	6.4	3.7	16	3.1
$PbB_{fetal,0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	34	9.1	15	8.8	39	7.4
PbB_t	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	10.0	10.0	10.0	10.0	10.0	10.0
$P(PbB_{fetal} > PbB_t)$	Probability that fetal PbB > PbB_t, assuming lognormal distri	%	**68%**	4%	**18%**	3%	**74%**	2%
PRG	Preliminary Remediation Goal (PRG)	ppm	**4601**	23003	9201	19011	**3195**	2045
	Clean Fill (assumed)	ppm	50				50	
	Remedial Action Level (RAL)	ppm	**78,900**				**16,700**	

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

5.4.2 Main Facility Area

In the main facility area, lead risks were evaluated for a construction worker and a utility worker exposed to subsurface soil (0-5 ft). The predicted 95th percentile fetal BLLs are 34 µg/dL for the construction worker and 9.1 µg/dL for the utility worker. The predicted BLL for the fetus of the construction worker exceeds the BLL goal of 10 µg/dL, thus lead in subsurface soil poses an unacceptable risk in the main facility area. The exceedance is due to the elevated subsurface soil EPC of 20,266 mg/kg, which represents the average concentration for depths of 0-5 ft across the site. The utility worker has a much lower exposure frequency than the construction worker, thus his predicted 95th percentile BLL is below the adult 95th percentile goal of 10 µg/dL.

5.4.3 Grassy Areas

In the grassy area, lead risks were evaluated for a future site worker, a groundskeeper, and an adolescent trespasser exposed to surface soil. The predicted 95th percentile fetal BLLs are 15 µg/dL for the groundskeeper, 8.8 µg/dL for the trespasser, and 39 µg/dL for the future site worker. The predicted fetal BLLs for the groundskeeper and the future site worker exceed the BLL goal of 10 µg/dL, thus lead in surface soil poses an unacceptable risk in this exposure area. This exceedance is due to the elevated surface soil lead concentration in the grassy area (15,916 mg/kg).

5.4.4 Offsite Natural Gas Facility

At the offsite natural gas facility, lead risks were evaluated for an offsite worker exposed to surface soil. The predicted 95th percentile fetal BLL is 7.4 µg/dL for the offsite worker. The predicted BLL is below the goal of 10 µg/dL, therefore, lead does not pose a significant risk to a worker exposed to surface soil in this exposure area.

5.5 Uncertainty Analysis

The process of evaluating human health risks involves multiple steps. Inherent in each step of the process are uncertainties that ultimately affect the final risk estimates. Uncertainties may exist in numerous areas, including sample collection, laboratory analysis, derivation of toxicity values, and estimation of potential site exposures. These uncertainties may result in either an over- or under-estimation of risks. However, for this risk assessment, where uncertainties existed, Gradient took a conservative approach in regards to parameters, assumptions, and methodologies, so as to overestimate potential exposures and risks. The most important contributors to uncertainty in this risk assessment are discussed below.

5.5.1 Uncertainties in Exposure Assessment

Soil Ingestion Rate. The adult soil ingestion rate used in the risk calculations and in the ALM was the USEPA default value of 0.05 g/day. However, a survey of recent literature suggests that the average soil and dust ingestion rate value for adults is closer to 0.02 g/day (Bowers *et al.*, 1994).

Lead Absorption Fraction. A lead absorption fraction used in the ALM was USEPA's default value of 0.12. This value is based on 20% absorption of lead from water, and 60% relative bioavailability of lead from soil (0.20 x 0.60 = 0.12). The 20% absorption of lead from water is an upper-end value based on consumption on an empty stomach. This is a conservative assumption that may overestimate risk. O'Flaherty (1993) suggests that a value of 8% may be a more appropriate absorption value for food and water in adults. This value assumes that people consume food at average mealtimes throughout the day, therefore the lead absorption rate is slower due to the presence of food in the stomach. If we use an adult soil ingestion rate of 0.02 g/day, combined with a lead absorption fraction of 8% (or for soil, 0.08 x 0.6 = 0.048), we find that the lead risks calculated for adult receptors could be on the order of 60-70% lower than those presented here. Thus the adult lead risks presented in this report are likely conservative overestimates.

Fraction from site. Each receptor's daily soil exposure was assumed to be solely from impacted soil within the exposure area. This is a conservative assumption, since it is expected that workers would be at the site for only 8 hours a day, and would be exposed to soil and dust from other sources during the remaining part of each day (*e.g.*, from home). For instance, in the grassy area, the exposure is likely overestimated for the future site worker, since we assumed he would obtain 100% of this daily soil ingestion during the hour or so that he visits the grassy area at lunchtime.

Exposure Duration. Gradient assumed an upper bound (95th percentile) exposure duration of 25 years for the future site worker, groundskeeper, and offsite gas facility worker (USEPA, 1991). This assumption is conservative and is likely to result in an overestimate of exposure and risk for most workers, since many workers do not remain at the same job for 25 years.

5.5.2 Uncertainties in Arsenic Risk Assessment

Risk management decisions for arsenic are confounded by the unusual nature of natural arsenic background risks, which for both food and water yield cancer risks of 10^{-4} or higher, and because of the substantial uncertainty associated with the arsenic cancer slope factor. This section describes some of the unique uncertainties associated with arsenic. In general, the assumptions we have used tend to overestimate arsenic risks.

5.5.2.1 Background Levels of Arsenic in Food, Water, Air, and Soil

Humans are exposed to low levels of arsenic in food, water, air, and soil (ATSDR, 2000). Food is typically the largest source of arsenic exposure, with dietary exposure accounting for about 70% of the daily intake of inorganic arsenic (Borum and Abernathy, 1994). The U.S. EPA estimates that the U.S. population ingests approximately 18 µg of inorganic arsenic every day from food (USEPA 1988). This translates into a 4×10^{-4} cancer risk estimate based on continuous lifetime exposure, and EPA's current assessment of the carcinogenic potential of arsenic.

In the U.S., the average background level of arsenic in drinking water is approximately 2 µg/L (ATSDR, 2000). The recent U.S. EPA rule allows a permissible level or maximum contaminant level (MCL) of 10 µg/L arsenic in drinking water (USEPA 2001b), a 5-fold lower value than the prior MCL of 50 µg/L. The rule allows community and non-transient, non-community water systems 5 years to attain compliance with the new MCL. Assuming the average background level and an ingestion rate of 2 L drinking water per day, an adult would ingest 4 µg inorganic arsenic per day. At the new MCL of 10 µg/L, an adult would ingest 20 µg inorganic arsenic per day, while at the old MCL of 50 µg/L, an adult would ingest 100 µg inorganic arsenic per day. These values translate into a range of cancer risk estimates between 9×10^{-5} and 2×10^{-3} based on continuous lifetime exposure, and EPA's current assessment of the carcinogenic potential of arsenic. EPA currently estimates that approximately 11 million people in the U.S. are served by community water systems with arsenic levels above the revised MCL. These people therefore have a cancer risk from water alone above 4×10^{-4}.

The mean levels of arsenic in ambient air range from less than 1 to 3 ng/m^3 in rural areas and from 20 to 30 ng/m^3 in urban areas (ATSDR, 2000). Assuming an inhalation rate of 20 m^3/day, an adult would breathe in less than 0.02 to 0.06 μg inorganic arsenic per day in rural areas, and 0.4 to 0.6 μg in urban areas. Arsenic levels could be higher in urban areas due to emissions from coal-fired power plants. However, the maximum concentrations measured in a 24-hour period are generally below 100 ng/m^3 (ATSDR, 2000). These background values translate into a range of cancer risk estimates between 4×10^{-7} and 1×10^{-5}.

Background arsenic levels in soil in Indiana range from 3.6 to 15 mg/kg, with an average concentration of 7.5 mg/kg (Dragun and Chiasson, 1991).

Total cancer risk from a combination of background exposures to arsenic in food, water, air, and soil may be as high as between 10^{-4} and 10^{-3} for a substantial portion of the U.S. population.

5.5.2.2 Body Burdens of Arsenic

Soil arsenic has a modest impact on body burden, as evidenced by urinary arsenic levels. Although elevated urinary arsenic levels were reported to be associated with very high soil arsenic levels near copper smelters (Baker *et al.*, 1977; Binder *et al.*, 1987), several studies consistently demonstrated that very low urinary arsenic levels were produced from soil arsenic concentrations below 200 mg/kg. In addition, the Anaconda, MT study demonstrated that urinary arsenic levels were unaffected by soil arsenic levels as high as 500 mg/kg. This observation occurs in part because of the small impact of soil arsenic relative to the impact of background levels of arsenic in food and water.

5.5.2.3 Bioavailability of Arsenic in Soil

Another explanation for the minor impact of soil arsenic on body burdens of arsenic is that arsenic in soil has a relatively low bioavailability and is absorbed into the body (*i.e.*, bloodstream) less efficiently than arsenic in water, the form used by U.S. EPA for the arsenic cancer slope factor. The bioavailability of arsenic in soil depends on two steps: solubilization in gastrointestinal (GI) fluids and absorption across the GI epithelium into the bloodstream (Valberg *et al.*, 1997). Both the solubilization and absorption depend on a variety of factors including the chemical forms of arsenic, the mode of intake by the individual (with or without food, type of food), and the nutritional status, which affects the pH throughout the GI tract, and GI transit time.

The solubility of arsenic depends on soil particle size and the associated soil matrix materials. Particle size affects solubility because larger particles dissolve more slowly than smaller particles, hence, the percentage dissolved during GI transit time increases as particle size decreases. Solubility of arsenic may be limited when insoluble matrix minerals (*e.g.*, quartz) encase arsenic compounds. Similarly, formation of iron-arsenic oxides and phosphates, and prevalence of authigenic carbonate and silicate complexes also limit the solubility of arsenic (Davis *et al.*, 1992 and 1996). The solubility in the GI tract is complex since the pH conditions change from low pH in the stomach to a much higher pH in the small intestine. Readily soluble arsenic compounds, such as arsenate and arsenite, are more bioavailable than poorly soluble arsenic compounds, such as arsenic trioxide (ATSDR, 2000).

Several animal studies have evaluated the bioavailability of soil-bound arsenic. Results from Freeman *et al.* (1993 and 1995) and Groen *et al.* (1994) indicated that soil-bound arsenic is not as bioavailable as arsenic in solution. The bioavailability of soil arsenic relative to aqueous arsenic administered by gavage was approximately 20 percent in monkeys and 48 percent in rabbits. The higher relative bioavailability in rabbits reflected the higher absolute bioavailability in this species. This was much lower than the 64 to 69 percent of arsenic recovered in urine after ingestion of dissolved arsenic by human volunteers (Johnson and Farmer, 1991). Casteel *et al.* (1997) conducted a multi-year investigation of bioavailability of metals in soil and mine wastes using young swine whose GI system is more similar to humans than other animals. The relative bioavailability of arsenic in soils at various mining and smelting sites ranged from 7 to 52%, which agreed with the results of previous studies by Freeman *at al.* and Groen *et al.* Rodriguez *et al.* (1999) performed a similar swine study that reported the range of 2.7 to 42.8% relative bioavailability of arsenic in soil. Based on Gradient's literature review, a relative bioavailability of 50% is the maximum value reported in any of the peer-reviewed, published arsenic bioavailability studies. This evaluation used a relative bioavailability of 80%, based on guidance from USEPA Region 10. The relative bioavailability of 80% is thus likely to overestimate arsenic risks.

5.5.2.4 Cancer Slope Factor (CSF) for Arsenic

Reports on arsenic toxicity in humans are largely based on exposure to arsenic compounds in media other than soil, for example, consumption of drinking water and inhalation in occupational settings. USEPA has derived toxicity factors, *i.e.*, reference dose (RfD) and cancer slope factor (CSF), for ingested arsenic based on data from a Taiwanese study evaluating the health effects associated with the consumption of water containing high concentrations of arsenic (Chen *et al.*, 1985; Tseng *et al.*, 1968). Although the application of the population data used to derive the RfD and CSF has been heavily debated (Carlson-Lynch *et al.*, 1994; Smith *et al.*, 1995; Beck *et al.*, 1995; Mushak and Crocetti, 1995 and 1996; Slayton *et al.*, 1996), the values derived are generally believed to be conservative.

The CSF is based on skin cancer observed in a study of over 40,000 people in Taiwan who were exposed for a significant portion of their lifetime to elevated levels of arsenic in groundwater. Although the study clearly indicates an association between high levels of arsenic exposure and cancer, the study design limits its usefulness to derive precise dose-response relationships. The reasons are summarized below:

Exposure Assessment. There are considerable scientific concerns about the exposure estimates in the Taiwanese study (USEPA Region 6, 1998). Individual exposures were not characterized, and exposures were based on average arsenic concentrations of ground water in wells in each village. The amount of exposure was broadly classified into three groups (high, medium and low) and the original data were not available. The analytical method used to measure arsenic concentrations may not be accurate at low levels.

Human-to-Human Variation. In general, dose levels, genetic factors, dietary patterns, or other life style factors may alter arsenic metabolism and detoxification in different populations (USEPA Region 6, 1998). Taiwanese may be more susceptible than U.S. population, and therefore CSF based on Taiwanese population may overestimate cancer for U.S. population. The protein deficiencies in Taiwanese diets could affect their ability to methylate and therefore detoxify arsenic, leading to an increase in cancer risk. Consequently, extrapolation from one population to another becomes highly uncertain.

Other Sources of Exposure. When the U.S. EPA derived the CSF, they did not take into account other possible sources of arsenic in the Taiwanese diet (*e.g.*, from rice and yams) and dietary uses of drinking water. Hence, the assumptions used by the U.S. EPA in deriving toxicity values for arsenic underestimate the total arsenic intake, and as a result, the CSF may overestimate cancer risks.

Non-Linear Dose-Response. A recent U.S. EPA panel concluded that the dose-response for arsenic appeared to be non-linear (USEPA, 1997b), and the U.S. EPA Region 6 concluded that the available data "support a plausible threshold" (USEPA Region 6, 1998). The possible sub-linear or threshold dose-response relationship suggests that cancer risk at low doses of arsenic may be less than predicted based on a linear model.

Arsenic Differs in Water and Soil. Health effects associated with arsenic in water may not be relevant to assess the toxicity in soil (Valberg *et al.*, 1997). Arsenic exists in different chemical forms in water and soil, which may lead to potential differences in systemic bioavailability and dose-to-target organ. The relative proportion of overall arsenic intake and the correlation with urinary-arsenic concentrations may also be different between arsenic in water and soil. The differences will ultimately impact the overall potential for adverse health effects.

Overall, these uncertainties limit precise quantification of the dose-response relationship, but suggest the current CSF may overestimate cancer risks for a U.S. population exposed to lower levels of arsenic. Two recently published articles provide evidence that the CSF overestimates the cancer risk for arsenic as applied to drinking water studies outside the U.S. (Guo and Valberg, 1997) and within the U.S. (Valberg *et al.*, 1998). These papers report a meta-analysis of epidemiological studies evaluating the skin cancer incidence of 29 populations in India, Japan, Mexico, Taiwan and the U.S. who were exposed to 1.17 to 270 µg/L arsenic in water. The authors evaluated the validity of U.S. EPA arsenic CSF model to predict the expected number of skin cancers by conducting a likelihood ratio analysis. This analysis showed that a null hypothesis of no additional skin cancer risk from arsenic was approximately two times more likely than the hypothesis of the predicted rate of skin cancer from arsenic. This analysis indicated that the CSF derived from arsenic exposure in the Taiwanese populations is likely to be an overestimate when applied to the U.S. populations.

Additionally, in the epidemiological studies of a U.S. population that has been exposed to arsenic in drinking water, no increased cancer rate has been observed (USEPA Region 6, 1998). This is further supported by studies of individuals exposed to arsenic in soil who thus far have not indicated any toxicity (Binder *et al.*, 1987; Wong *et al.*, 1992).

5.5.2.5 Summary of Arsenic Risks and Uncertainty

Any effect of arsenic in soil on total arsenic body burden is difficult to observe as a result of the commonly reduced bioavailability of arsenic in soil, and the extent to which soil's contribution to body burden is overwhelmed by background levels of arsenic in food and water. Coupling these considerations with the uncertainty in the derivation of the arsenic cancer slope factor suggest that an acceptable risk level for soil arsenic may be close to 10^{-4}.

5.5.3 Uncertainties in Risk Characterization

Uncertainties associated with the first three steps of the risk assessment (data collection, exposure assessment, and toxicity assessment) are incorporated into the risk estimates in the risk characterization step. Although there are numerous uncertainties associated with this risk assessment, the incorporation of a large number of conservative assumptions has yielded risk estimates that are likely to overestimate actual site risks.

6 Soil Lead Cleanup Levels

Lead risks are unacceptable for the construction worker in the main facility area, and the groundskeeper and the future site worker in the grassy area. Therefore, soil lead cleanup levels were calculated for these areas.

A preliminary remediation goal (PRG) is the average concentration in an exposure area that will result in an acceptable risk to a particular receptor. PRGs are risk-based target cleanup levels that must be met *on average* throughout the exposure area. It is acceptable to leave concentrations that exceed the cleanup level, so long as the post-remediation *average* concentration does not exceed the risk-based cleanup level.

The Remedial Action Level (RAL) is the concentration above which soil must be removed, so that the post-remediation *average* concentration meets the specified target cleanup level (USEPA, 2001c). The RAL is a remedial action goal (*i.e.,* a remediation trigger concentration) that ensures the post-remediation average concentration at a site achieves the target cleanup level with a specified level of confidence.

PRGs for lead were calculated for subsurface soil (0-5 feet) in the main facility area and surface soil (0-6 inches) in the grassy area (Table 7). In the main facility area, the PRG for lead in subsurface soil is 4600 mg/kg for the construction worker. In the grassy area, the PRG for surface soil is 3195 mg/kg for the future site worker.

RALs were calculated for these two receptors, assuming that excavated soil would be replaced with clean backfill containing lead at 50 mg/kg. The RAL for the main facility area is 78,900 mg/kg for subsurface soil. The RAL for surface soil in the grassy area is 16,700 mg/kg.

7 Conclusions

Cancer risks attributable to arsenic were calculated for receptors in three exposure areas. All of the calculated cancer risks fall within USEPA's target risk range of 1×10^{-6} to 1×10^{-4}. The exposure scenario with the highest excess lifetime cancer risk is the future site worker in the grassy area (4×10^{-5}). The exposure pathway with the greatest contribution to cancer risk is soil ingestion.

Noncancer risks attributable to arsenic were calculated for receptors in three exposure areas. All of the calculated noncancer risks are below USEPA's target hazard index of 1.0, indicating that significant health effects are unlikely. The exposure scenario with the highest noncancer risk is the onsite construction worker (HI of 0.4). The exposure pathway with the greatest contribution to noncancer risk for the resident is soil ingestion.

Lead risks were evaluated for adult and/or adolescent receptors in three exposure areas. Lead risks were evaluated by comparing the predicted fetal BLL for each receptor to USEPA's BLL goal of 10 µg/dL. Predicted 95th percentile fetal BLLs exceeded USEPA goals for the construction worker exposed to subsurface soil in the main facility area, and the groundskeeper and future site worker exposed to surface soil in the grassy area. Lead in surface soil does not pose a significant risk for the offsite gas facility worker.

8 References

Abernathy, C.O., W. Marcus, C. Chen, *et al.* 1989. Internal Memorandum to P. Cook/P. Preuss re: Report on Arsenic (As) Work Group Meetings. US EPA, Office of Drinking Water, Washington, DC.

Advanced GeoServices Corp. (AGC). 2002. Phase II RCRA Facility Investigation Report. Prepared for Refined Metals Corp. (Beech Grove, IN). November 18.

Advanced GeoServices Corp. (AGC). 2000. Advanced GeoServices Corp. RCRA Facility Investigation Report. Prepared for Refined Metals Corp. (Beech Grove, IN). August 31.

ATSDR. 1999. Research Triangle Institute (Research Triangle Park, NC) July 1999. "Toxicological profile for lead (update)." Report to US Public Health Service, Agency for Toxic Substances and Disease Registry (ATSDR) National Technical Information Service (NTIS) (Springfield, VA) NTIS PB99-166704.

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Syracuse Research Corp. "Toxicological profile for arsenic (Update.)" National Technical Information Service (Springfield, VA) Prepared for US Public Health Service, Agency for Toxic Substances and Disease Registry (ATSDR) NTIS PB2000-108021. 446p. September.

Alexander, M. 2000. Aging, bioavailability, and overestimation of risk from environmental pollutants. *Environmental Science and Technology* 34(20):4259-4265.

American Cancer Society (ACS). 2000. Statistics: Cancer Facts and Figures. www.cancer.org/statistics/index. Retrieved August 2, 2000.

Baker, E., C. Hayes, P. Landrigan, J. Handke, R. Leger, W. Houseworth and J. Harrington. 1977. A nationwide survey of heavy metal absorption in children living near primary copper, lead, and zinc smelters. *Am. J. Epidemiol.* 106(4):261-273.

Beck, B.D., P.D. Boardman, G.C. Hook, R.A. Rudel, T.M. Slayton and H. Carlson-Lynch. 1995. Correspondence: Response to Smith *et al. Environ. Health Perspect.* 103(1):15-16.

Binder, S., D. Forney, W. Kaye and D. Paschal. 1987. Arsenic exposure in children living near a former copper smelter. *Bull. Environ. Contam. Toxicol.* 39:114-121.

Bornschein, R.L., P.A. Succop, K.M. Krafft, *et al.* 1986. Exterior surface dust lead, interior house dust lead and childhood lead exposure in an urban environment. In *Trace Substances in Environmental Health, II, 1986, A Symposium* (Ed: D.D. Hemphill), University of Missouri, Columbia, pp. 322(11).

Borum, D.R. and C.O. Abernathy. 1994. Human oral exposure to inorganic arsenic. In: Arsenic, Exposure and Health (W.R. Chappell, C.O. Abernathy and C.R. Cothern, Eds.), p. 21-29. Science and Technology Letters, Northwood, England.

Bowers, T.S., Beck, B.D., Karam, H.S. 1994. Assessing the relationship between environmental lead concentrations and adult blood lead levels. *Risk Analysis, Volume 14, No.2.*

Calabrese, E.J. and E.J. Stanek. 1992. What proportion of household dust is derived from outdoor soil? *J. Soil Contam.* 1(3):253(11).

Carlson-Lynch, H., B.D. Beck and P.D. Boardman. 1994. Arsenic risk assessment: A commentary. *Environ. Health Perspect.* 102(4):354-356.

Casteel, S.W., L.D. Brown, M.E. Dunsmore, C.P. Weis, G.M. Henningsen, E. Hoffman, W.J. Brattin, and T.L. Hammon. 1997. Relative bioavailability of arsenic in mining wastes. Report to EPA, Region 8.

Centers for Disease Control (CDC). 1991. "Draft CDC Lead Statement: Preventing Lead Poisoning in Young Children." March.

Chappell, W.R., B.D. Beck, K.G. Brown, R. Chaney, C.R. Cothern, K.J. Irgolic, D.W. North, I. Thornton, and T.A. Tsongas. 1997. Inorganic arsenic: A need and an opportunity to improve risk assessment. *Environmental Health Perspectives* 105(10):1060-1067.

Chen, C.-J., Y.-C. Chuang, T.-M. Lin and H.-Y. Wu. 1985. Malignant neoplasms among residents of a blackfoot disease-endemic area in Taiwan: High arsenic artesian well water and cancers. *Cancer Res.* 45:5895-5899.

Davis, A., M.V. Ruby and P.D. Bergstrom. 1992. Bioavailability of arsenic and lead in soils from the Butte, Montana, mining district. *Environmental Science and Technology* 26(3):461-468.

Davis, A., M.V. Ruby, M. Bloom, R. Schoof, G. Freeman and P.D. Bergstrom. 1996. Mineralogic constraints on the bioavailability of arsenic in smelter-impacted soils. *Environmental Science and Technology* 30(2):392-399.

Dragun, J. and A. Chiasson. 1991. *Elements in North American Soils.* Hazardous Materials Control Resources Institute, Maryland, 238p.

Fergusson, J.E. and N.D. Kim. 1991. Trace elements in street and house dusts: Sources and speciation. *Sci. Total Environ.* 100:125-150.

Freeman, G.B., J.D. Johnson, J.M. Killinger, S.C. Liao, A.O. Davis, M.V. Ruby, R.L. Chaney, S.C. Lovre and P.D. Bergstrom. 1993. Bioavailability of arsenic in soil impacted by smelter activities following oral administration in rabbits. *Fundamental Applied Toxicology* 21:83-88.

Freeman, G., R. Schoof, M. Ruby, A. Davis, J. Dill, S. Liao, C. Lapin and P. Bergstrom. 1995. Bioavailability of arsenic in soil and house dust impacted by smelter activities following oral administration in cynomolgus monkeys. *Fundamental Applied Toxicology* 28:215-222.

Groen, K, H.A.M.G. Vaessen, J.J.G. Kliest, J.L.M. deBoer, T. van Ooik, A. Timmerman and R.F. Vlug. 1994. Bioavailability of arsenic from bog ore-containing soil in the dog. *Environmental Health Perspective* 102(2):182-184.

Guo, H.R. and P.A. Valberg. 1997. Evaluation of the validity of the US EPA's cancer risk assessment of arsenic for low-level exposures: A likelihood ratio approach. *Environ. Geochem. Health* 19:133-141.

Johnson, L.R. and J.G. Farmer. 1991. Use of human metabolic studies and urinary arsenic speciation in assessing arsenic exposure. *Bull. Environ. Contam. Toxicol.* 46:53-61.

Mushak, P. and A.F. Crocetti. 1995. Commentary: Risk and revisionism in arsenic cancer risk assessment. *Environ. Health Perspect.* 103(7-8):684-689.

Mushak, P. and A.F. Crocetti. 1996. Correspondence-Response: Accuracy, arsenic, and cancer. *Environ. Health Perspect.* 104(10):1014-1018.

O'Flaherty, E.J. 1993. Physiologically based models for bone-seeking elements. IV. Kinetics of lead disposition in humans. *Toxicol. Appl. Pharmacol.* 118 :16-29.

Rodriguez, R.R., N.T. Basta, S.W. Casteel and L.W. Pace. 1999. An *in vitro* gastrointestinal method to estimate bioavailable arsenic in contaminated soils and solid media. *Environmental Science and Technology* 33(4):642-649.

Ruby, M.V., R. Schoof, W. Brattin, M. Goldade, G. Post, M. Harnois, D.E. Mosby, S.W. Casteel, W. Berti, M. Carpenter, D. Edwards, D. Cragin, and W. Chappell. 1999. Advances in evaluating the oral bioavailability of inorganics in soil for use in human health risk assessment. *Environmental Science & Technology* 33(21):3697-3705.

Slayton, T.M., B.D. Beck, K.A. Reynolds, S.D. Chapnick, P.A. Valberg, L.J. Yost, R.A. Schoof, T.D. Gauthier, and L. Jones. 1996. Correspondence: issues in arsenic cancer risk assessment. *Environ. Health Perspect.* 104(10):1012–1014.

Smith, A.H., M.-L. Biggs, C. Hopenhayn-Rich and D. Kalman. 1995. Correspondence: Arsenic risk assessment. *Environ. Health Perspect.* 103(1):13-15.

Stanek, E.J. and E.J. Calabrese. 1995. Soil ingestion estimates for use in site evaluations based on the best tracer method. *Human Ecol. Risk Assess.* 1(2):133-156.

TriAD. 1997. RCRA Facility Investigation Report for SWMUs 1, 3, 4, and 6. June 27.

Tseng, W.P. 1977. Effects and dose response relationships of skin cancer and blackfoot disease with arsenic. *Environ. Health Perspectives* 19:109-119.

Tseng, W.P., H.M. Chu, and S.W. How. 1968. Prevalence of skin cancer in an endemic area of chronic arsenicism in Taiwan. *J. Nat. Cancer Inst.* 3:453(10).

U.S. Dept. of Housing and Urban Development (U.S. HUD). 1995. "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing." June.

U.S. Environmental Protection Agency (USEPA). 1988. Special Report on Ingested Inorganic Arsenic - Skin Cancer: Nutritional Essentiality, EPA/625/3-87/013, July.

U.S. Environmental Protection Agency (USEPA). 1989. "Risk Assessment Guidance for Superfund (RAGS), Vol. I, Human Health Evaluation Manual (Part A)." Office of Emergency and Remedial Response, Washington, D.C. OSWER Directive 9285.7-01A. EPA-540/1-89-002. December.

U.S. Environmental Protection Agency (USEPA). 1991. "Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual. Supplemental Guidance: Standard Default Exposure

Factors. Interim Final." Office of Emergency and Remedial Response, Toxics Integrations Branch, Washington, DC. OSWER Directive: 9285.6-03. March 25.

U.S. Environmental Protection Agency (USEPA). 1992. "Guidelines for Exposure Assessment." *Federal Register* 57 (104) :22888(50). May 29.

U.S. Environmental Protection Agency (USEPA). 1992a. "Dermal Exposure Assessment : Principals and Applications, Interim Report." Exposure Assessment Group, Office of Health and Environmental Assessment, Washington, D.C. EPA/600/8-91/011B.

U.S. Environmental Protection Agency (USEPA). 1992b. "Supplemental Guidance to RAGS: Calculating the Concentration Term." Office of Solid Waste and Emergency Response, Washington, D.C. PB92-963373. May.

U.S. Environmental Protection Agency (USEPA). 1992c. "Integrated Risk Information System (IRIS): EPA's Approach for Assessing the Risks Associated with Chronic Exposures to Carcinogens. Background Document 2." www.epa.gov/ngispgm3/iris/carcino.htm. January 17. Retrieved January 11, 2001.

U.S. Environmental Protection Agency (USEPA). 1993. "Integrated Risk Information System (IRIS): Reference Dose (RfD): Description and Use in Health Risk Assessments. Background Document 1A." www.epa.gov/ ngispgm3/iris/rfd.htm. March 15. Retrieved January 11, 2001.

U.S. Environmental Protection Agency (USEPA). 1994. "Guidance manual for the Integrated Exposure Uptake Biokinetic Model for lead in children." US EPA, Technical Review Workgroup for Lead. Prepared for UP EPA, Office of Emergency and Remedial Response (Research Triangle Park, NC) OERR Publication 9285.7-15-1; EPA540-R-93-081; NTIS PB93-963510. February.

U.S. Environmental Protection Agency (USEPA). 1996. "Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil." Technical Review Workgroup for Lead. December.

U.S. Environmental Protection Agency (USEPA). 1997a. "Exposure Factors Handbook. Volumes I, II, III." Office of Research and Development, Washington, D.C. EPA/600/P-95/002Fa-c. August.

U.S. Environmental Protection Agency (USEPA). 1997b. "Report on the Expert Panel on Arsenic Carcinogenicity: Review and Workshop." National Center for Environmental Assessment, Washington, DC. August.

U.S. Environmental Protection Agency (USEPA). 1998a. "Clarification to the 1994 Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities." Office of Solid Waste and Emergency Response. OSWER Directive #9200.4-27, EPA/540/F-98-030. August.

USEPA. 1998b. IEUBK model mass fraction of soil in indoor dust (M_{SD}) variable. Office of Emergency and Remedial Response. EPA 540-F-00-008. OSWER 9285.7-34. June.

U.S. Environmental Protection Agency (USEPA). 1999. "Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual-Supplemental Guidance: Dermal Risk Assessment Interim Guidance (Final Draft)." Office of Emergency and Remedial Response, Washington, DC. March 14.

U.S. Environmental Protection Agency (USEPA). 2001a. 40 CFR Part 745: Lead; Identification of dangerous levels of lead (Final rule.). Fed. Reg. 66 :1205-1240. January 5. http://www.epa.gov/fedrgstr/EPA-TOX/2001/January/Day-05/t84.pdf

U.S. Environmental Protection Agency (USEPA). 2001b. Drinking water standards for arsenic. Office of Water. EPA 815-F-00-015. January.

U.S. Environmental Protection Agency (USEPA). 2001c. Office of Emergency and Remedial Response (Washington, DC). "Risk assessment guidance for Superfund (RAGS). Volume III: Part A, Process for conducting probabilistic risk assessment." EPA 540-R-02-002; Publication 9285.7-45; PB2002-963302. 385p. December. http://www.epa.gov/superfund/programs/risk/rags3adt/pdf/chapters.pdf.

U.S. Environmental Protection Agency (USEPA). 2002. Office of Emergency and Remedial Response (Washington, DC). "Calculating upper confidence limits for exposure point concentrations at hazardous waste sites [Supplemental guidance to RAGS.]" OSWER Directive 9285.6-10. 32p. December. http://www.epa.gov/superfund/programs/risk/ragsa/ucl.pdf.

U.S. Environmental Protection Agency (USEPA). 2003. Technical Review Workgroup for Lead. "Recommendations of the Technical Review Workgroup for Lead for an approach to assessing risks associated with adult exposures to lead in soil." Report to US EPA, Office of Solid Waste and Emergency Response/Office of Emergency and Remedial Response (Washington, DC) EPA-540-R-03-001; OSWER Directive 9285.7-54. January. http://www.epa.gov/superfund/programs/lead/products/adultpb.pdf.

U.S. Environmental Protection Agency (USEPA). 2004a. Integrated Risk Information System (IRIS). Arsenic, inorganic. http://www.epa.gov/iris/subst/0278.htm

U.S. Environmental Protection Agency (USEPA). 2004b. Integrated Risk Information System (IRIS). Lead and compounds (inorganic). http://www.epa.gov/IRIS/subst/0277.htm.

U.S. Environmental Protection Agency Region 6 (USEPA Region VI). 1998. "Region 6 Interim Strategy: Arsenic – Freshwater Human Health Criterion for Fish Consumption, Appendix B: Health Effects of Arsenic." http://www.epa.gov/earth1r6/6wq/ecopro/watershd/standard/arsenic.htm. Retrieved May 6, 1998; last updated February 4, 1998.

U.S. Public Health Service, 2004. National Health and Nutrition Examination Survey, 1999-2000. (NHANES, 2000). National Center for Health Statistics. Downloaded from: http://www.cdc.gov/nchs/about/major/nhanes/NHANES99_00.htm - Laboratory%20Files.

Valberg, P.A., B.D. Beck, P.D. Boardman, and J.T. Cohen. 1998. Likelihood ratio analysis of skin cancer prevalence associated with arsenic in drinking water in the U.S. *Environmental Geochemistry and Health* (In press).

Valberg, P.A., B.D. Beck, T.S. Bowers, J.L. Keating, P.D. Bergstrom, and P.D. Boardman. 1997. Issues in setting health-based cleanup levels for arsenic in soil. *Regul Toxicol Pharmacol* 26:219-229.

Wong, O., M.D. Whorton, D.E. Foliart, R. Lowengart. 1992. An ecologic study of skin cancer and environmental arsenic exposure. *Int. Arch. Occup. Environ. Health* 64:235-241.

Appendix A

Risk Calculation Tables

Appendix A
Arsenic Risk Summary

Receptor/Exposure Pathway		Cancer Risk	Hazard Index
Onsite Construction Worker			
Dermal Contact with Soil		5.11E-07	0.0159
Ingestion of Soil		2.07E-06	0.064
	Total:	**3E-06**	**0.1**
Onsite Utility Worker			
Dermal Contact with Soil		2.05E-07	0.0032
Ingestion of Soil		8.27E-07	0.013
	Total:	**1E-06**	**0.02**
Grassy Area Site Worker			
Dermal Contact with Soil		6.52E-06	0.041
Ingestion of Soil		3.77E-05	0.23
	Total:	**4E-05**	**0.3**
Grassy Area Groundskeeper			
Dermal Contact with Soil		6.47E-06	0.040
Ingestion of Soil		1.31E-05	0.08
	Total:	**2E-05**	**0.1**
Grassy Area Adolescent Trespasser			
Dermal Contact with Soil		3.54E-07	0.011
Ingestion of Soil		1.58E-06	0.049
	Total:	**2E-06**	**0.1**
Offsite Gas Facility Worker			
Dermal Contact with Soil		2.66E-06	0.017
Ingestion of Soil		5.38E-06	0.033
	Total:	**8E-06**	**0.1**

Appendix A
Excess Lifetime Cancer Risk by Chemical and Pathway for All Receptors

Ingestion of Soil

Receptor	Chemicals Evaluated	Intake Factor (IF)	Soil Concentration (C) (mg/kg)	Bioavailability (R)	Daily Intake DI = C×IF×R (mg/kg·d)	Slope Factor (SF) (kg·d/mg)	Cancer Risk CR = DI×SF
Onsite Construction Worker	Arsenic	1.40E-08	123	8.00E-01	1.38E-06	1.5	2.07E-06
Onsite Utility Worker	Arsenic	5.59E-09	123	8.00E-01	5.51E-07	1.5	8.27E-07
Grassy Area Site Worker	Arsenic	1.01E-07	312	8.00E-01	2.51E-05	1.5	3.77E-05
Grassy Area Landscaper	Arsenic	3.49E-08	312	8.00E-01	8.71E-06	1.5	1.31E-05
Grassy Area Adolescent Trespasser	Arsenic	4.22E-09	312	8.00E-01	1.05E-06	1.5	1.58E-06
Offsite Gas Facility Worker	Arsenic	1.57E-07	28.5	8.00E-01	3.59E-06	1.5	5.38E-06

Notes:

Daily Intake (DI) = Concentration (C) * Intake Factor (IF) * Bioavailability (R)

where:

IF = Intake Factor (IR * FS * EF * ED * CF) / (BW * AT)
AT = Averaging Time - Noncancer (d)
AT = Averaging Time - Cancer (d)
BW = Body Weight (kg)
CF = Conversion Factor (kg/mg)
ED = Soil Ingestion Exposure Duration (yr)
EF = Soil Ingestion Exposure Frequency (d/yr)
FS = Fraction Soil from Contaminated Source
IR = Soil Ingestion Rate (mg/d)

Appendix A
Excess Lifetime Cancer Risk by Chemical and Pathway for All Receptors

Dermal Contact with Soil

Receptor	Chemicals Evaluated	Intake Factor (IF)	Soil Concentration (C) (mg/kg)	Dermal Absorption (A)	Daily Intake DI=C×IF×A (mg/kg·d)	Slope Factor (SF) (kg·d/mg)	Cancer Risk CR=DI×SF
Onsite Construction Worker	Arsenic	9.23E-08	123	3.00E-02	3.41E-07	1.5	5.11E-07
Onsite Utility Worker	Arsenic	3.69E-08	123	3.00E-02	1.36E-07	1.5	2.05E-07
Grassy Area Site Worker	Arsenic	4.65E-07	312	3.00E-02	4.35E-06	1.5	6.52E-06
Grassy Area Landscaper	Arsenic	4.61E-07	312	3.00E-02	4.31E-06	1.5	6.47E-06
Grassy Area Adolescent Trespasser	Arsenic	2.52E-08	312	3.00E-02	2.36E-07	1.5	3.54E-07
Offsite Gas Facility Worker	Arsenic	2.08E-06	28.5	3.00E-02	1.77E-06	1.5	2.66E-06

Notes:

Daily Intake (DI) = Concentration (C) * Intake Factor (IF) * Dermal Absorption (A)

where:

IF = Intake Factor (AF * SA * EF * ED * CF) / (BW * AT)
AT = Averaging Time - Noncancer (d)
AT = Averaging Time - Cancer (d)
BW = Body Weight (kg)
CF = Conversion Factor (kg/mg)
ED = Soil Dermal Exposure Duration (yr)
EF = Soil Dermal Exposure Frequency (events/yr)
SA = Surface Area Exposed to Soil (cm^2/event)
AF = Soil Soil/Skin Adherence Factor (mg/cm^2)

Appendix A
Noncancer Hazard Quotient by Chemical and Pathway for All Receptors

Ingestion of Soil

Receptor	Chemicals Evaluated	Intake Factor (IF)	Soil Concentration (C) (mg/kg)	Bioavailability (R)	Daily Intake DI = C×IF×R (mg/kg·d)	Reference Dose (RfD) (mg/kg·d)	Hazard Quotient HQ=DI÷RfD
Onsite Construction Worker	Arsenic	1.96E-07	123	8.00E-01	1.93E-05	3.00E-04	6.43E-02
Onsite Utility Worker	Arsenic	3.91E-08	123	8.00E-01	3.85E-06	3.00E-04	1.28E-02
Grassy Area Site Worker	Arsenic	2.82E-07	312	8.00E-01	7.03E-05	3.00E-04	2.34E-01
Grassy Area Landscaper	Arsenic	9.78E-08	312	8.00E-01	2.44E-05	3.00E-04	8.14E-02
Grassy Area Adolescent Trespasser	Arsenic	5.90E-08	312	8.00E-01	1.47E-05	3.00E-04	4.91E-02
Offsite Gas Facility Worker	Arsenic	4.40E-07	28.5	8.00E-01	1.00E-05	3.00E-04	3.35E-02

Notes:

Daily Intake (DI) = Concentration (C) * Intake Factor (IF) * Bioavailability (R)

where:

IF = Intake Factor (IR * FS * EF * ED * CF) / (BW * AT)
AT = Averaging Time - Noncancer (d)
AT = Averaging Time - Cancer (d)
BW = Body Weight (kg)
CF = Conversion Factor (kg/mg)
ED = Soil Ingestion Exposure Duration (yr)
EF = Soil Ingestion Exposure Frequency (d/yr)
FS = Fraction Soil from Contaminated Source
IR = Soil Ingestion Rate (mg/d)

Appendix A
Noncancer Hazard Quotient by Chemical and Pathway for All Receptors

Dermal Contact with Soil

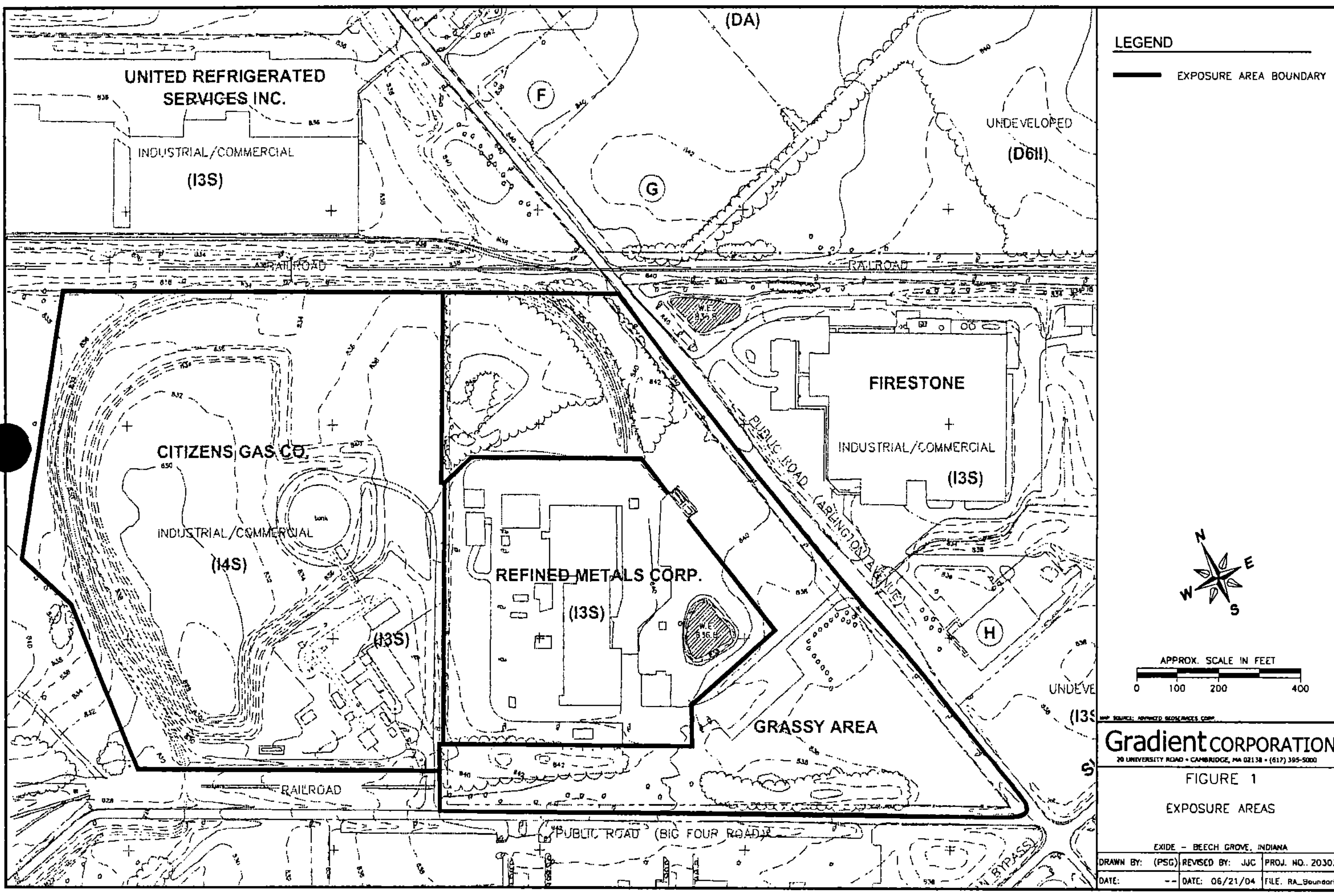
Receptor	Chemicals Evaluated	Intake Factor (IF)	Soil Concentration (C) (mg/kg)	Dermal Absorption (A)	Daily Intake DI=C×IF×A (mg/kg-d)	Reference Dose (RfD) (mg/kg-d)	Hazard Quotient HQ=DI÷RfD
Onsite Construction Worker	Arsenic	1.29E-06	123	3.00E-02	4.77E-06	3.00E-04	1.59E-02
Onsite Utility Worker	Arsenic	2.58E-07	123	3.00E-02	9.54E-07	3.00E-04	3.18E-03
Grassy Area Site Worker	Arsenic	1.30E-06	312	3.00E-02	1.22E-05	3.00E-04	4.05E-02
Grassy Area Landscaper	Arsenic	1.29E-06	312	3.00E-02	1.21E-05	3.00E-04	4.02E-02
Grassy Area Adolescent Trespasser	Arsenic	3.53E-07	312	3.00E-02	3.30E-06	3.00E-04	1.10E-02
Offsite Gas Facility Worker	Arsenic	5.81E-06	28.5	3.00E-02	4.97E-06	3.00E-04	1.66E-02

Notes:

Daily Intake (DI) = Concentration (C) * Intake Factor (IF) * Dermal Absorption (A)

where:

IF = Intake Factor (AF * SA * EF * ED * CF) / (BW * AT)
AT = Averaging Time - Noncancer (d)
AT = Averaging Time - Cancer (d)
BW = Body Weight (kg)
CF = Conversion Factor (kg/mg)
ED = Soil Dermal Exposure Duration (yr)
EF = Soil Dermal Exposure Frequency (events/yr)
SA = Surface Area Exposed to Soil (cm^2/event)
AF = Soil Soil/Skin Adherence Factor (mg/cm^2)


LEGEND
EXPOSURE AREA BOUNDARY
(DA)
UNITED REFRIGERATED SERVICES INC.
INDUSTRIAL/COMMERCIAL
(I3S)
F
G
UNDEVELOPED
(D6II)
RAILROAD
RAILROAD
CITIZENS GAS CO.
INDUSTRIAL/COMMERCIAL
(I4S)
(I3S)
REFINED METALS CORP.
(I3S)
FIRESTONE
INDUSTRIAL/COMMERCIAL
(I3S)
PUBLIC ROAD (ARLINGTON AVENUE)
H
GRASSY AREA
RAILROAD
PUBLIC ROAD (BIG FOUR ROAD)
N
E
W
S
APPROX. SCALE IN FEET
0 100 200 400
Gradient CORPORATION
FIGURE 1
EXPOSURE AREAS
EXIDE - BEECH GROVE, INDIANA
DRAWN BY: (PSG) REVISED BY: JJC PROJ. NO. 203030
DATE: -- DATE: 06/21/04 FILE: RA_Boundaries